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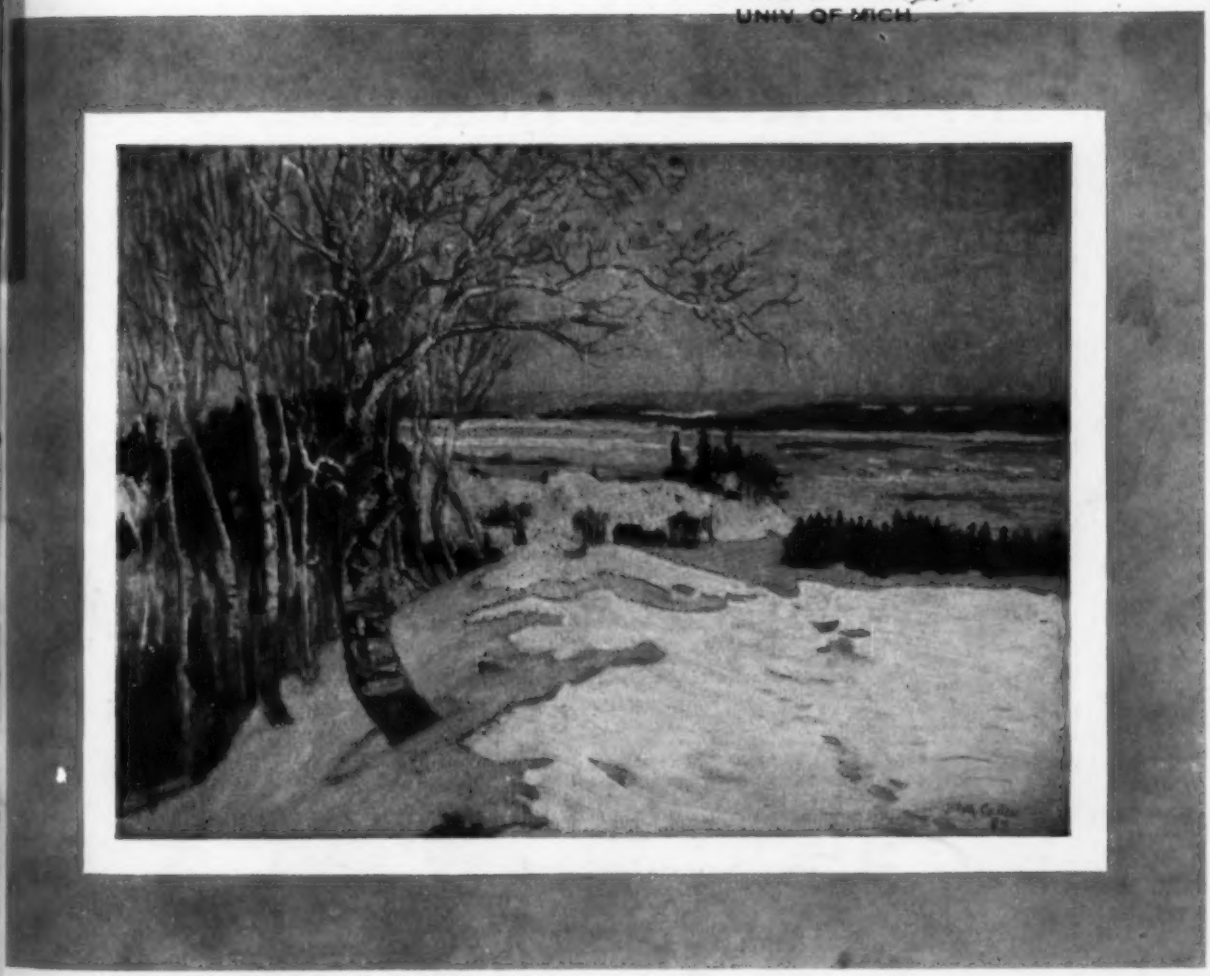

MAURICE G. CULLEN R.C.A. *"On the St. Lawrence"* Courtesy of the Rous & Mann Press Ltd.

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Ontario's Tercentenary

by

WILLIAM SHERWOOD FOX

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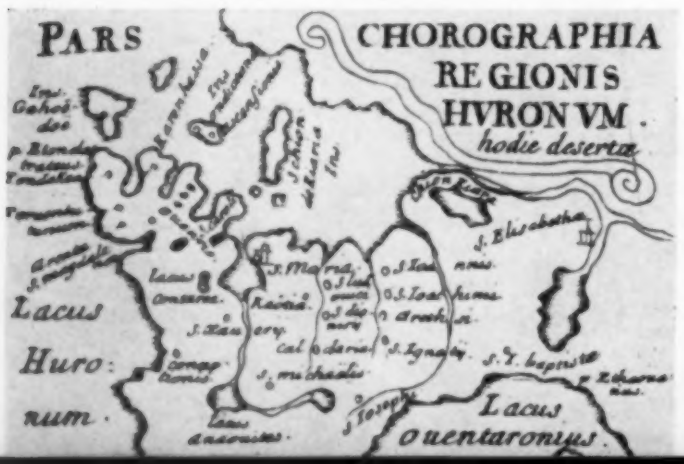
Jean de Brébeuf.

THE YEAR 1949 marks the tercentenary of memorable events in the history of Canada. The fact that they have to do with a European community established in Ontario before Maisonneuve founded Montreal confers on Ontario an antiquity of which few Canadians are aware. Under the name of Huronia part of Simcoe County in that province will always be famous, for within its borders occurred two great crises in our secular and religious annals: on March 16, 1649, the martyrdom of the noble missionaries, St. Jean de Brébeuf and St. Gabriel Lalemant, and in June of that year the abandonment of the French Jesuit mission on the mainland of Huronia. To grasp the significance of these tragic events one must look back to the very beginnings of New France.

New France was still young when French Jesuits saw in it a field divinely opened for their apostolic effort. To them the pagan aborigines were so many souls to be saved. In Port Royal, the first French colony in Acadia, they found their first opportunity for service. In 1611 two of their priests were posted there, but, discouraged by the attitude of the civil authorities, withdrew in 1613 to found a station of their own. A few days later an English pirate ship sailed into their quiet haven, blew up their stores and scattered their entire company. But even this was not enough to quench their zeal, for the wilderness still teemed with Indians to be brought to the fold.

But to which of the many nations should they carry their message? Clearly, they could obtain no lasting results among a nomadic folk; so they ruled out the roving



Map of Huronia from Du Creux's Tabula Novae Franciae, *Paris, 1660.*

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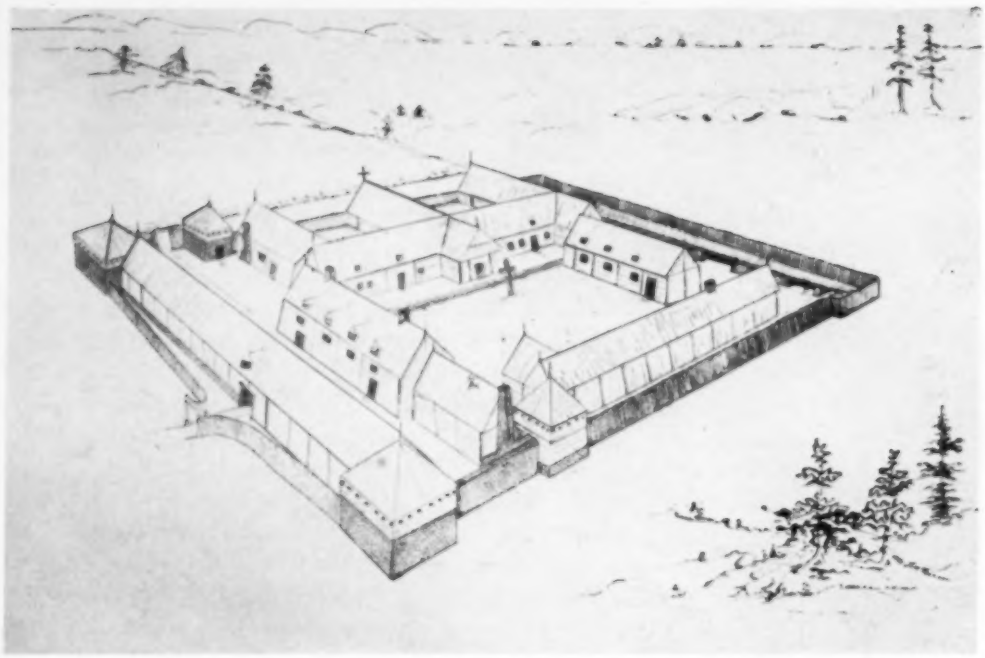
Gabriel Lalemant, from the Jesuit Relations.

Algonquins. Of the fixed populations the most accessible were the Iroquois, Andastes, Neutrals and Hurons. It so happened that through their annual trading visits to Quebec the Hurons became known to Champlain as early as 1608 and so keen was his interest in them that he spent the winter of 1615-16 among them. His experience convinced him that they would readily accept the Christian faith and adopt the ways of civilization. His persuasion was a major factor in leading the Jesuits to dedicate themselves to bringing the gospel to Huronia.

And where is Huronia? It is really a peninsula, barely forty by twenty miles in extent, which forms the northern part of Simcoe County, Ontario. Its bounds are sharply defined by nature: on the south, Lake Simcoe; on the east and northeast, Lake Couchiching and the Severn Rivers; on the north, Matchedash Bay; on the west, Nottawasaga Bay. The Hurons themselves believed their land to be an island.

Early in the seventeenth century the only safe route for travellers between Quebec and the Huron country was long, devious and difficult: the St. Lawrence, the Ottawa, the Mattawa Rivers, the portage to Lake Nipissing, the voyage down the French River and southward through the myriad islands of the Georgian Bay. The other and shorter route by way of the upper St. Lawrence, the Trent, Lake Simcoe and the Severn, was blocked by the Huron's bitter enemy, the Iroquois. Little did the missionaries suspect that in yielding their lives to the salvation of the Hurons they were to fan the ancient feud to a heat that destroyed

G. H. Reavely



Fort St. Marie as it might have looked. A drawing made by Fraser Metcalf and Sister Loyola, based upon the results of excavations made by K. Kidd and in 1948 by Wilfrid Jury.

their whole mission. In that irony lies the reason for our story.

Actually the first missionaries among the Hurons were several Recollet Fathers who in 1623 set up a station near the site of the present Penetanguishene. For several reasons their effort did not thrive and with their blessing they handed over their field to the Society of Jesus. In the summer of 1626 Jean de Brébeuf, a member of this order, with two companions, one a Jesuit and the other a Recollet, made the fatiguing journey to Huronia and established their first station at Toanché, the place where Champlain landed in 1615. Though their spirits were buoyant and prospects bright the path ahead proved to be rough and cruel. Abruptly, in the late spring of 1629 Brébeuf was called to Quebec by a report that Sir William Kirke was sailing up the Gulf to seize the colony. During the English occupation, which lasted until 1632, Brébeuf, along with all other members of the French orders, was exiled to France. In that year England ceded New France back to Louis; though Brébeuf returned as soon as the ban was lifted he still had to wait two years before he could resume his work in Huronia.

August 5, 1634, is a crucial date in the chronicles of the Huron Mission: on that day Brébeuf and two other Fathers set foot once more on their field of labour. They took up their residence in the village of Ihonatiria which lay near the northern tip of the westernmost prong of the Huronian peninsula. To this they gave the name St. Joseph. For the time being they made it their base of operations as they visited all parts of the Huron territory.

Everywhere they met strong resistance in many forms: suspicion, persecution, treachery and even physical violence. Nevertheless, they made steady headway. Little by little three factors won for them the confidence of the majority: their moral integrity, obvious unselfishness and skill in contriving novel defences against the foe. In three or four villages of strategic importance the Fathers made conspicuous progress. Realizing now that St. Joseph was too far to one side of Huron territory they reorganized their plan of operation by basing it on these strong stations.

So by 1637 the headquarters were provisionally removed southward to Ossossané, a pious village on Nottawasaga Bay; this they renamed La Conception. A year later their problem in regard to St. Joseph was solved by the outbreak of a pestilence, probably smallpox, which drove away all the surviving inhabitants. Forthwith the missionaries transferred their own residence and their dismayed parishioners to Téanostayé, a populous town on the southern fringe of

the Huron country and which was exposed to Iroquois attack. This new home was called St. Joseph II. Though their advent was fiercely resisted the pastors clung tenaciously to their new foothold and in time won popular esteem and trust. Attached to this station were the mission hamlet of St. Ignace which lay six or seven miles to the northeast, and, fifteen miles distant to the east, close to the eastern boundaries of Huronia, the village of St. Jean Baptiste, a settlement so steeped in paganism as to be the Fathers' despair.

But, after all, these two shifts were but of a minor nature, for in the master plan the station of St. Marie on the Wye River (near the present Midland) was to become the mother house of the whole mission. In 1639 the work of building on this site was begun and was carried on continuously until the grievous last days of 1649. Thus St. Marie, established as a civilized community provided with residences and fortifications designed to be permanent, has the honour of being three years older than the ancient metropolis of Montreal.

Meanwhile the Iroquois raids came in such rapid succession that by 1648 they had become an invasion. On July 4 of that year the enemy descended in force upon St. Joseph II, burned it, massacred or enslaved its inhabitants and killed its noble pastor, Father Antoine Daniel, who thus became the first martyr of Huronia. Alarmed by this calamity the people of St. Jean Baptiste fled to St. Ignace and on the advice of Brébeuf the merged population of the two places sought a safer site for a new home nearer to fortified St. Marie. The site selected was a level plateau lying fifty feet above the Sturgeon River and fortified by nature on three sides by the steep banks of the river and two deep gullies. The erection of a stout palisade sixteen feet in height around the area and the addition of other defensive devices contrived jointly by Huron and Frenchman, made the new fortress seem to be impregnable—at least for savages. Work on the defences and on the building of houses was begun in the early spring of 1648 and under the pressure of fear was carried on continuously for nearly a year. This task, as we now know, was never finished. Fittingly, the new city of refuge was named St. Ignace II.

Hard by its gates the Iroquois lurked in the forest and watched. Observing that most of the able warriors were away the enemy without warning attacked St. Ignace before dawn on March 16, 1649. For this assault they had craftily crept close to the weak side of the defences, the side protected only by the man-made palisade. With their hatchets they noiselessly undermined the tall stakes planted in the soft yielding sand. According to Father Ragueneau and others the scenes

The ruins of Fort St. Marie II on Christian Island. From a sketch by Father Felix Martin in 1855, published in Old Huronia.

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The martyrdom of Jean de Brébeuf and Gabriel Lalemant. A Flemish engraving made from the original in Historia Canadensis *by Father Du Creux published in 1664.*

that ensued surpass in horror the wildest powers of the imagination.

Most of the inhabitants left in the town—women, children and feeble old men—were ruthlessly put to death then and there, while the rest were held as prisoners to be led away later to the Iroquois country. The torch was applied to the palisade and to some of the many buildings. Two or three wounded Hurons who escaped from the flames and slaughter trudged half-naked through the deep snow and brought word of the disaster to St. Louis, a large mission village which lay about three miles to the west and midway between St. Ignace and St. Marie. In St. Marie itself the resident Fathers and their large company of Frenchmen and Hurons saw the pillar of flame and smoke to the east of them and in terror waited to learn what it meant.

The warning given to St. Louis was of little avail, for the Iroquois followed hard on the messengers' heels and soon overcame the gallant resistance of the Huron warriors. It so happened that at the time Fathers Brébeuf and Lalemant were in St. Louis. They were immediately seized by the invaders and dragged away to St. Ignace. Here they were systematically subjected to tortures so fiendish that one shrinks from recording them. Brébeuf was bound to a stake in a public place and a slow fire was kindled around him. Lalemant was wrapped in a sheet of resinous pine bark and then, forced inside an Indian lodge, was gradually burned to death. But neither victim of these cruelties flinched for an instant. Both died glorifying God for the privilege of testifying to the reality of their faith in Him. On March 20 a band made its way from St. Marie to St. Ignace and bore back the mutilated remains of the two pastors. Here "the revered bodies were buried with all possible ceremony on the twenty-first of March, which was a Sunday, while each of those present desired rather than feared a like death for himself".* Later the sacred relics were taken to Quebec.

The enemy centred all their offensive power upon St. Marie. The Fathers, French helpers and Huron converts who had taken refuge behind its ramparts succeeded in surviving the winter, but in June, to escape the perils of a siege, crossed in a body to Christian Island and there set up a second mission and fortress of St. Marie. Here, their numbers thinned by famine and disease, they remained for a year. In June of 1650, aware that the end had come, most of the Huron remnant fled singly or in small bands to the far west, while a small but devout company went with their pastors to Quebec.

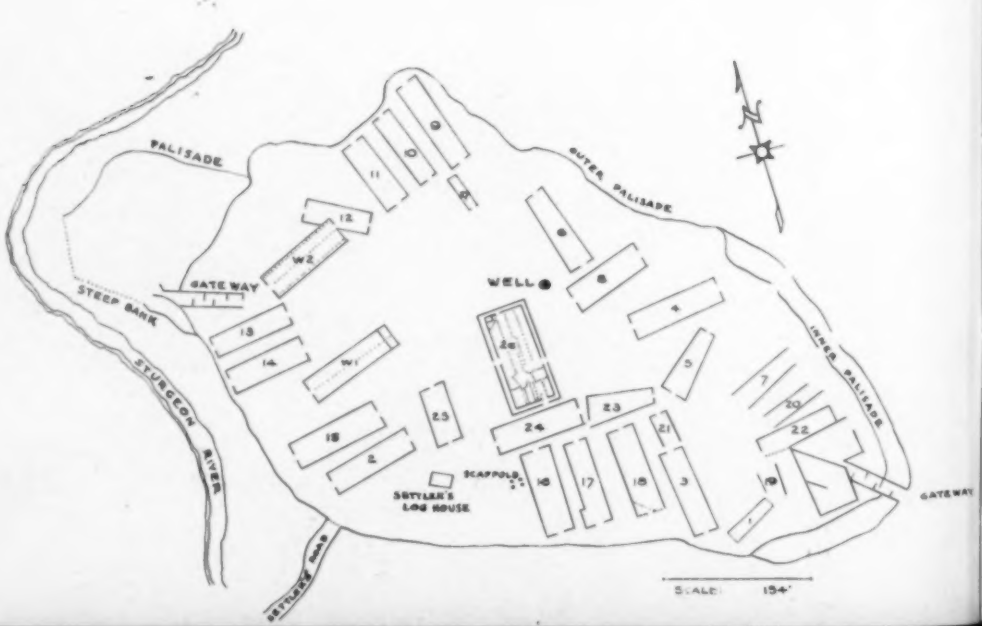
*Du Creux, *Historia Canadensis*, Paris, 1664.

Objects found in the Chapel-Residence at St. Ignace II. Left to right, front row: a celt; flint knife; wrought-iron knife blade; back row: piece of charred wood; hammer stone and shell beads.

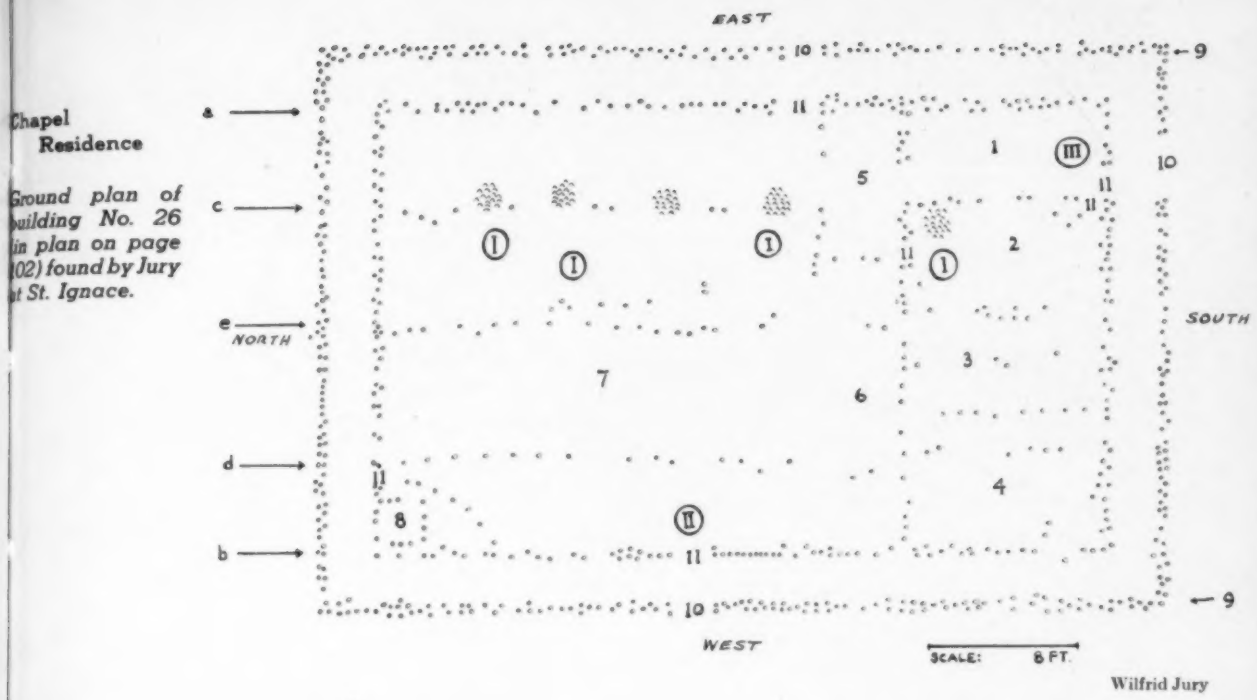
An aerial view of the site of St. Ignace II showing the wooded ravines on three sides.

But where was St. Ignace ? Unmarked by mounds of enduring stone as was St. Marie it was lost in an unpeopled wilderness. Not until the return of the Jesuits to Canada in 1842 was there anyone to take an interest in it. In that year a succession of scholars began to look for it. About 1932 it fell to the lot of a humble woodsman, Alphonse Arpin of Midland, to discover promising traces of the place. Arpin could find no one in Midland to listen to him. He told his problem to Thomas Connon of Goderich who passed it on to the University of Western Ontario. The University secured the services of the expert Indian archaeologist, W. J. Wintemberg of the National Museum at Ottawa. In two short summer campaigns of digging in 1937 and 1938 Wintemberg uncovered enough remains of a strongly palisaded Huron-French village to convince him that the place was really St. Ignace. In 1939 the outbreak of war and in 1941 Wintemberg's death put an end to the investigation for the time being. On August 1, 1946, the task was taken up by Wilfrid Jury, the University's curator of Indian archaeology, who completed it three months later.

The three campaigns brought to light a palisaded area over six acres in extent. Its

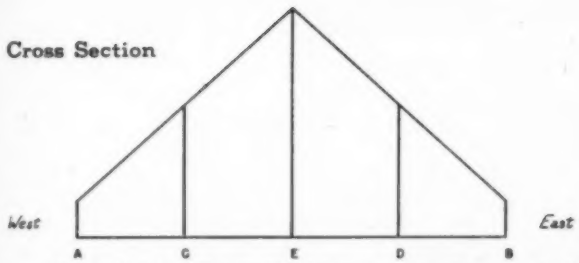


Ground plan of St. Ignace, by Wilfrid Jury, 1946, as revealed by the excavations of Wintemberg and Jury. W1, W2 are houses found by Wintemberg; 1 to 25, buildings of various kinds found by Jury; 26, Chapel-Residence; 27 storage shed.



Ground plan of building No. 26 (in plan on page 102) found by Jury at St. Ignace.

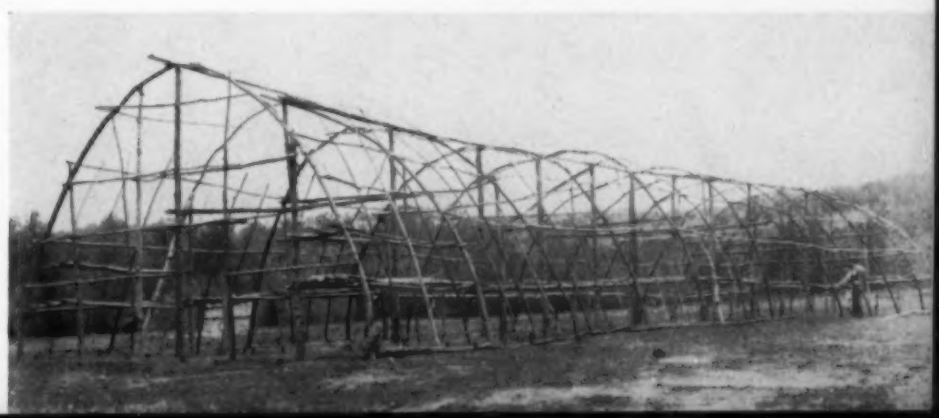
Wilfrid Jury



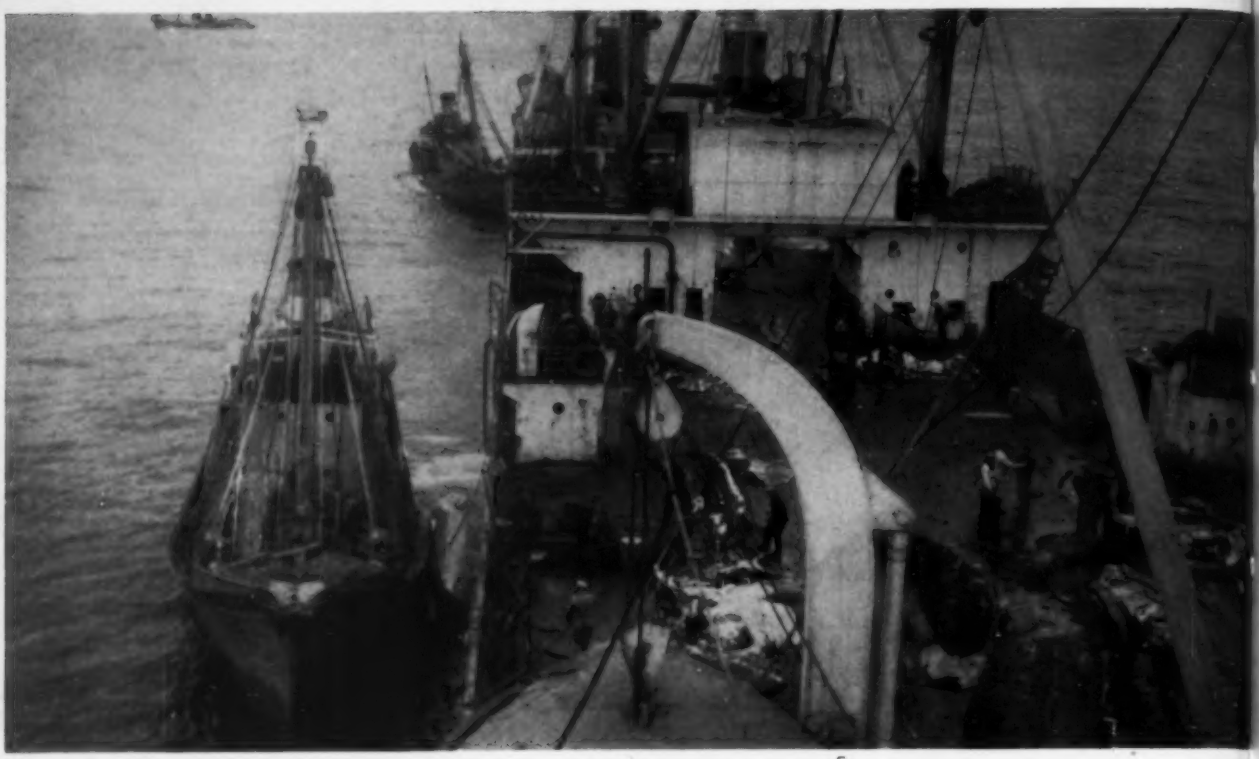
A, B: Side walls. C, D, E: Rows of roof posts. 1: Kitchen. 2: Refectory. 3: Sleeping room. 4: Common room. 5: Sacristy. 6: Place for altar. 7: Assembly. 8: Confessional. 9: Fence. 10: Gateway. 11: Doorway.

natural defences coincided with the descriptions contained in the *Jesuit Relations*. Within the stockade were found objects of French origin and twenty-nine buildings, mostly long houses, roofed and walled with elm bark. In the centre of the village tract was one building of special importance—the Chapel-Residence. It was a huge structure, its ground plan measuring sixty by ninety-nine feet.

Jury's discovery of these remarkable remains, outlined by rows of post moulds that had been buried in the soil, clinched the conviction that this site was none other than that of St. Ignace, the long sought Canadian altar of martyrdom. On this hallowed spot, had it been found years earlier, would have been raised the imposing Martyrs' Shrine which now from its lofty eminence looks down as in reverence upon the partly restored walls and battlements of St. Marie that lie below on the bank of the placid Wye.



Framework of the reconstructed long house (Jury building No. 2) at St. Ignace II.



Above:—Factory ship on the whaling grounds, showing catching vessel Southern Soldier *taking on bunker oil from the 'Mother' ship, using a whale as a fender.*

Left:—Stern view of factory ship showing ramp which passes between the twin funnels and up which whales are hauled by two 40-ton steam winches. Such a ship has a speed of over 12 knots.

The catching vessel Southern Foam *bringing in six sperm whales. This species of toothed whales forms the catch in the early part of the December to April season, before the start of the main baleen (toothless or whalebone) whale catch.*

Whaling and Its Antarctic Problems Today

by HARRY R. LILLIE

Photographs by the author

OVER A THOUSAND years ago man started the active pursuit of the cetaceans, both baleen and toothed whales, following his discovery that specimens stranded on the sea beaches could provide him with food and fuel. An era of relentless hunting coincided with the industrial age, when by the middle of the nineteenth century, whale oil was mainly used as a lubricant, illuminant, and in the tanning and textile industries. The fame of Dundee in Scotland, as a whaling port, was a direct result of the use of the oil for batching in the jute industry. Only in certain isolated areas of the northern hemisphere was the meat used as food by the human inhabitants.

A depression in the industry followed in the second half of the nineteenth century, when whale oil as a crude lubricant was largely replaced by mineral oils, and gas came in for lighting; but in the early part of the present century, physics and chemistry developed the conversion of whale oil into edible fat such as margarine. This, soap (with glycerine as a by-product) and high grade lubricants, are some of the many products from the oil today.

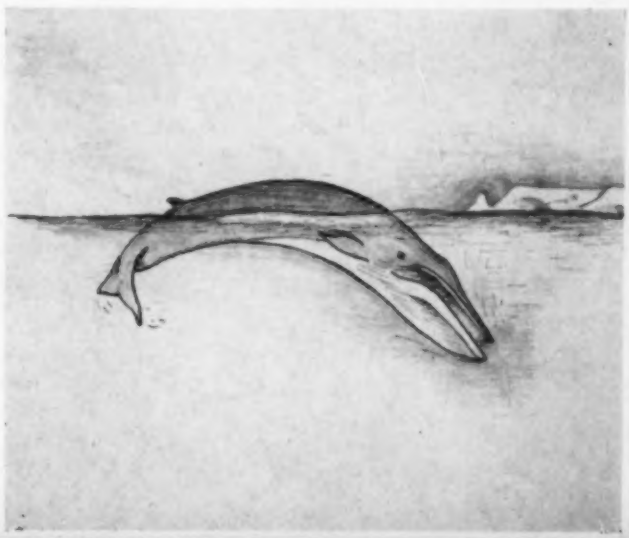
In the early days, iron harpoons thrown by hand were used from row boats, based on land at first, and later working from sailing 'Mother' ships, alongside which the whales were stripped of blubber, and the rest of the carcass discarded. Right whales and sperms were then the animals hunted, species which floated when dead. Catching the blue, fin and sei whales which are chased today was not then practicable as they swam too fast and sank when dead, so that no rowing boat could hold them. Those big blue whales today may be over ninety feet long and weigh well over a hundred tons; equal to a troupe of twenty elephants.

At the middle of the last century, America was the leading nation in whaling, with over seven hundred vessels engaged mainly on sperm hunting; but her interest was gradually lost to the counter attraction of the development of the western prairies coinciding with depletion of the whales. Then came the day in the latter half of the century, when the Norwegian Svend Foyn put his newly invented harpoon gun into action, mounted on steam chasing vessels; and this, firing an explosive harpoon, finally displaced the old hand weapon, and made the catching of all species of the larger whales easy.

Uncontrolled commercial exploitation by several countries followed, and by the beginning of the present century, the stock of whales in the northern hemisphere had been almost destroyed. A Norwegian company started whaling from a base at Durban, in South Africa, in 1908, and in the next three years a number of companies operated from shore stations on the African coast. But the main attention turned to the still virgin waters of the Antarctic, when the Norwegian Captain C. A. Larsen aroused the interest of the Argentine. The Campañia Argentina de Pesca, founded in 1903, and at present operating from Grytviken, in the Island of South Georgia in the Falkland Islands Dependencies, was the first to develop the industry to any extent in the Antarctic, followed by Norway and Britain from shore stations in both South Georgia and the South Shetlands. Soon after, floating factories made their appearance, a development of the old days of the sailing 'Mother' ships. The animals were caught by the same steam catchers, but instead of being towed long distances to shore stations, were treated on board these parent ships, completely self contained units, now steam propelled and able to move to wherever whales were plentiful. This modern version of pelagic whaling soon became a new menace to the stock of baleen whales in what was previously their one remaining sanctuary on the globe.

By 1930 there were forty-three of these factories, mainly operating in the Ross Sea area. In September, 1931, not a day too soon, the League of Nations drafted the International Convention for the Regulation of Whaling, concerned with the conservation of baleen whales from indiscriminate slaughter. It became international law in 1935, and, condensed in a few words, it prohibited the taking of any right whale, blue whale under sixty feet in length, fin whale under fifty feet, or any female accompanied by a calf. As a true conservation measure it was a failure. There was no limitation of total catch, and the allowable lengths of whales captured was far too small. In spite of the Discovery Committee's findings in 1929, that the blue whale becomes sexually mature at over seventy feet, whales only sixty feet long could be destroyed, which was long before they had a chance to reproduce themselves even once.

Now, after two world wars, with a tremendous increase in the human population of the world, food production has dropped to a very low level. Whale oil, which before World War II was valued at $60 per ton, has now reached over $400 per ton, and



Top, left:—Chasing a school of fin whales which are running hard. They can keep up nearly fourteen knots for an hour before they begin to tire.

Centre, left:—The catching vessel overtaking a fin whale, as it comes to the surface to breathe. The harpoon is seen travelling through the air with a foregoer rope running out behind it.

Bottom, left:—Looking down on a flagged fin whale alongside the catcher. Whales are inflated and marked with a flag and an electric light, to be picked up later.

A baleen whale in the diving position after surfacing to blow.

A blue whale being hauled up the stern ramp of the factory ship. The most valuable of whales, they are in greatest danger of extermination. Blue whales are toothless or baleen whales whose food consists of myriads of small shrimp-like creatures known as krill.

whale meat, from having been wasted for the extraction of a trivial three per cent of oil, has become the most valued product at $800 per ton for human consumption as meat. In Britain today it is the same price as the best Canadian beef. Only by the local inhabitants of certain areas of Norway, the Faroes, Greenland, and Japan had its real value been appreciated in the past.

Since the onset of pelagic whaling, Holland, Germany, and Japan have come into the industry in the Antarctic, followed by Russia on a small scale, while South Africa, with interests previously centred in Durban, has also come south. New Zealand and Australia are taking an increasing interest. In the 1946-47 season, fifteen factory ships operated in the Antarctic, three large vessels from the United Kingdom, seven smaller Norwegian craft, one Dutch, one South African, two Japanese, and one Russian ship. Germany has not yet resumed activities. Four of these factories were over 30,000 tons displacement. The number of whales killed was nearly thirty thousand, and nothing in statistics of length of animals caught would indicate that there had been any recovery of the stock during the non-whaling war years; a more serious warning is to be taken from the fact that it would appear that the percentage of females pregnant has dropped considerably. Two more new Norwegian factories brought those operating in the 1947-48 season to seventeen, when over 31,000 whales were killed, and the number of blue whale units taken was over 17,500, considerably in excess of the internationally allowed quota. Everything points to the onset of a repetition of the unfortunate history of the industry in the northern hemisphere. A present internationally agreed quota of 16,000 blue whale units* as the maximum allowable total Antarctic catch appears now to be far too high for an animal which produces only one calf every two to three years. Not all countries engaged in whaling co-operated by observing the International Convention. The Japanese have never done so until recently, and indiscriminate slaughter on their part has had a still more unfortunate effect in their sector of the Antarctic.

There have been various amendments to the 1935 agreement, and the last whaling conference at Washington in 1946 established an improved International Whaling Convention, which was proclaimed on February 5th, 1948, following its acceptance by Australia, Canada, Denmark, France, Great Britain, Iceland, New Zealand, Norway, South Africa, Soviet Russia, and

* A blue whale unit is a blue whale 100 feet long and is equivalent to two fin whales, or six sei whales.

the United States. Japan, under the administration of the United States, has now to abide by the convention laws.

The main features in it are that the permissible Antarctic catch of baleen whales is still 16,000 blue whale units, but this will be under constant review. The minimum lengths of whales which can be taken are increased—blue whales to be not less than seventy feet, fin whales not less than fifty-five feet, and other species in proportion; except in cases where whales are taken by land stations for the consumption of meat by local inhabitants, when permissible lengths are slightly less. The taking of any female accompanied by a calf is of course prohibited. The taking of grey whales or right whales is not allowed anywhere, except when the meat and products are used by local aborigines. The South Pacific from approximately Cape Horn to the Ross Sea south of 40° south latitude, is a sanctuary for baleen whales at all times, and no humpback whale can be taken anywhere south of 40° south latitude.

All factory ships have to report details of their catch weekly by radio to the Whaling Regulation authorities in Norway who decide the date on which whaling shall cease, should it appear that the quota allowed would be reached before the provisionally agreed date for ceasing operations.

This quota of 16,000 B.W.U. for the 1947-48 season was approached ahead of time, so all countries were notified that the Antarctic season would end at midnight on 31st March, a week before the provisional date. This was due mainly to the two extra Norwegian factory ships at work. The Russian expedition was the only one which did not report its catch on time as required. Including those attached to shore stations, one hundred and eighty-four catching vessels were active, while twelve ships of various sizes transported meat and whale oil to Europe and Japan.

Since the last war, radar, azdic, and even aircraft have been added to the whalers' equipment, in addition to still faster catching vessels capable of over fifteen knots. But the sad fact remains that with all these inventions and improvements, the actual killing today with the explosive harpoon is more cruel and economically unsound than was the original method at the dawn of the industry. More cruel than it would be to a human, for in a whale, wound shock gives no relief; and economically bad, for the explosive harpoon is the most wasteful weapon possible. The harpoon head explosion in the majority of cases bursts the intestines and spreads putrefactive organisms through-

Blue whale on the flensing deck lying partly on its back. The fringes of baleen or whalebone can be seen along the upper jaw through which the sea water is filtered to trap the krill. This specimen was 93 feet in length, its estimated weight well over one hundred tons.

Sperm whale at the start of the blubber stripping process. In the lower jaw can be seen the teeth used for holding the cuttlefish and squid which form the bulk of the sperms' food. The massive head occupies more than a third of the sperm's length.

out the circulation. Early putrefaction of the entire carcass sets in, with rapid loss of oil yield, and the production of a meat marketed for human consumption which has so far been anything but popular. Only in the comparatively few cases when the whale is speedily killed by a harpoon striking a vital spot away from the intestines altogether can a satisfactory meat be produced. Fresh whale meat consumed on the whaling grounds can hardly be distinguished from prime freshly killed beef in either appearance or flavour, but the complaints so often heard in Britain that the meat is oily to taste or smells fishy, means only one thing—putrefaction has already set in. Only by giving up this primitive explosive harpoon can whale meat ever come into its own as a reliable and valuable food for humans.

Meanwhile hundreds of millions of dollars' worth of it is being wasted annually, enough to feed Europe for over three months on present rations.

A whale swimming is a wonderful sight, the poetry of majestic motion, and to see one of these beautiful creatures pouring blood and gasping along on the surface towing a four-hundred-ton catching vessel on the end of a heavy harpoon rope is pitiful. Anything up to an hour is the usual time taken for them to die, but time and again it takes two or three hours and three, four and more harpoons to tear and blast the life out of one of them. One extreme case witnessed by the author was five hours and nine harpoons to kill a female blue whale in advanced pregnancy. These mother whales fight desperately for their lives and those of their babies. Occasionally a whale will be killed in less than five minutes and even instantly by a lucky shot, but gunners able to do that more than very occasionally are few indeed.

Part of the unfortunate wastage of whaling. A mother blue whale on the flensing deck and her unborn, ten-foot-long baby. The blue whale calf is twenty-three feet in length at birth.

If we imagine a horse having two or three explosive spears driven into its stomach, then made to drag a heavy truck through the streets of one of our cities or on the prairie, while it poured blood until it finally collapsed an hour or more later, then we would have a slight idea of what a whale goes through. Why in the last fifty years of whaling nothing has ever been done to overcome this unfortunate state of things is difficult to understand. One Norwegian explained to me that some gunners do not want any improvements that might throw them out of employment or require fewer catching vessels. But the Norwegians with whom the writer sailed on the catching craft on the whaling grounds invariably agreed that reform was needed, and more than once commented that if whales could scream, nobody could stand it and the industry in its present form would come to a speedy end. But these creatures have no vocal cords.

There has been a definite passive resistance on the part of some gunners and others in the industry where the trial of new methods is concerned, and this has held up field research to some considerable extent in the past. But there are now indications of an awakening among whaling countries generally to the realization that the present obsolete methods must be superseded by a clean, humane, economical way of killing.

Some years ago the Norwegians went into the question of electrocution, and investigations into other methods were started in the Antarctic in the 1946-47 season. Research has gone on steadily since then, with the co-operation of United Whalers Ltd. of London, and the Universities Federation for Animal Welfare, also with its headquarters in London. Drug manufacturers, gas specialists, manufacturing chemists, cable and electrical firms, and others have been most helpful, and given liberally of their time and advice.

Four possibilities have been explored.

1. The use of a drug such as curare or hydrogen cyanide.
2. A gas such as carbon dioxide or nitrous oxide.
3. Alteration in the type of explosive in the harpoon head.
4. Electrocution.

The use of curare or hydrogen cyanide was primarily to cause paralysis of the whale, and prevent diving, enabling the catching vessel to close in and kill by a harpoon or lance into a vital spot at close range. The aim was to fire the drug in a two-foot dart from a shoulder gun of the anti-tank type the moment the first harpoon, which would be non-explosive, was seen to strike; the poison being in a capsule which could burst in the muscle after penetration. Curare would have been suitable, but had to be ruled out as supplies are not available in sufficient quantity. Hydrogen cyanide has been considered too dangerous in view of the possibility of pockets of the drug being left unabsorbed in muscle and later consumed by humans.

In using a compressed gas, such as carbon dioxide, or nitrous oxide, it would be fired into the whale in a container, with the object of possibly forming a gas embolism or giving the animal sufficient excess buoyancy to prevent diving. Such buoyancy would require about 150 cubic feet of expanded gas, requiring a compression container too large for fitting to an ordinary harpoon. But carbon dioxide may act both in the formation of an embolism, and as a narcotic. An experiment carried out on one ship in the 1946-47 season with compressed carbon dioxide in the harpoon head was promising. An advantage of the use of carbon dioxide is the increased acidity of the meat which results, with consequent improved keeping qualities. Comparatively slow release of the gas is essential to avoid rupture of the intestines. But this method is likely to be very inefficient if the harpoon does not strike somewhere in the forepart of the body.

The present explosive harpoon carries a bursting grenade head charge of one pound of gunpowder, and the idea of replacing this with a reduced charge of high explosive was considered, but abandoned in view of the danger of handling misfires embedded in the whales. Also, of course, high explosive

Leith Harbour, the Scottish whaling station in South Georgia. Two of the factory ships are at their moorings and a typical whale-catching vessel is coming alongside.

would in no way lessen the damage to the intestines, which is the cause of the failure of the present harpoon.

Electrocution is almost certainly the solution of the problem. It has already proved a workable proposition, using current of approximately 200 volts, 30 amperes, generated on the catching vessel, and passed into the whale through a flexible copper cable leading along the harpoon forgoer rope to the harpoon itself. Two hundred whales are reported to have been killed by the Norwegians in a similar way in 1934, and half a dozen catchers fitted with electrical gear the following year; but the whole thing appears to have been shelved soon after. About the same time a British company tried it and gave it up after a rather half-hearted experiment, in which careless handling apparently led to a gunner receiving a minor shock and a whale being inefficiently electrocuted. It appears now, however, that only a little more adjustment in the detailed design is needed to make the equipment already evolved thoroughly reliable.

By the co-operation in Britain of the firms of United Whalers, and the General Electric Company of London, with the Universities Federation for Animal Welfare, a British harpoon vessel has now been fitted out with electrical equipment for the Antarctic season 1948-49. New Zealand and Australia are co-operating in use of the new gear, and the results, it is hoped, will speedily revolutionize harpooning. Nylon whale ropes and lighter harpoons are coming in with the electricity, and the new methods will shorten considerably the length of time the expeditions have to remain in Antarctic waters. The season is now one of three months active whale catching, and with an inevitable reduction in the quota of whales allowed to be killed, this period may well be down to two months within the next two to three years.

One of the British whaling companies during the past year has tried to reduce the waste from decomposition of the meat, by using converted naval corvettes as butcher ships. Their function was to take over the whales from the catching vessels, eviscerate them and let the cold sea water into the intestinal cavity, and then speed up the time of towing back to the factory ship. This is necessarily only a temporary expedient until the explosive harpoon is abolished, as the real damage is done to the meat while the creatures are in their long struggles before death.

Reform is needed throughout the industry. Seven days a week of catching is too much, and attention should be given to the whaling stations, some of which are extremely squalid; the stations should be orderly and

clean (as some are) and the waters around kept free from that scourge of animals and birds—the fuel oil which traps them.

To the Scottish whaling fleets the Island of South Georgia is the first outpost of the frozen south. Over one hundred miles long by fifteen miles wide, it lies out in the Atlantic, twelve hundred miles east of Cape Horn. There, most of the catching fleets remain at the land based stations through the long dark winter, to refit and prepare for November the first month of the Antarctic summer, when the big factory ships will call on their way from Britain to the whaling grounds many hundreds of miles still farther south on the edge of the pack ice.

To those whose lives are not entirely devoted to worship of the god of whale oil, South Georgia also means elephant and leopard seals, penguins, and a fascinating, ever changing pattern of other bird life. This island must have more glaciers packed into its tortuous coast line than almost any other spot on earth, and in winter is just a glorified iceberg. But for an all too brief summer, the snow clears from some of the lower slopes of the mountains, and amid the areas of grey green tussac grass the elephant seals, penguins and other creatures have their short breeding season before returning to the ocean for another year. Happy, trusting, lovable people all.

Enough has been said of the horrors of the whale catching in its present antiquated form, but even as seen from amid the blood soaked welter of a factory ship's deck, the Antarctic is a place of real beauty. As the big bergs go drifting by in the summer twilight, fantastic shapes with weird emerald lighting, and caves of gradually deepening translucent sapphire, you have serious doubts as to whether you are in the same world as the so-called civilization experienced a short time previously; and you wonder if perhaps you are really in the company of Alice and the White Rabbit, and the penguin sitting on a whale moored alongside is just the Dodo after all.

A penguin stands on a dead fin whale, a group of which are moored to the factory ship. In the background three killer whales (or grampuses) are coming in to eat the tongues of the dead whales.

W. V. Crich

Cirrus clouds four or five miles above the ground. They consist of streamers of ice crystals and are generally the advance notice of the approach of a warm, moist air mass with, usually, bad weather 700 or 800 miles in the rear.

Meteorology in Peace and War

by J. PATTERSON

THE LAST WAR brought very forcibly to the attention of all governments and the public the vital part that weather plays in all types of operation required for the conduct of a modern war in the air, on land, and on the sea. Moreover, the armed services made demands for weather information which in many cases the Meteorological Services did not possess, with the result that a great impetus was given to research and to the development of new equipment and technique to meet these requests.

Briefly, some of the main uses for which nations require meteorology in war and peace are:

IN WAR

Information on clouds, fogs, thunderstorms, visibility, temperature, and winds in the upper air, icing and turbulence, is required by the aviators on land and sea, during the time they are in the air. The artillery and naval officers require most of these factors but especially temperature and wind, in connection with bombardment, etc. The transatlantic ferrying of aircraft which grew to such immense proportions towards the end of the war depended almost entirely on the weather, and good forecasts made the operation successful. The naval service requires sea and swell information as far in advance as possible for landing armies. The general staff must know the general character of the weather at the scene of operations to choose if possible the best time for an offensive or know the weather they might have to meet if on the defensive; they require forecasts as far in advance as possible for the offensive and to be on the alert if on the defensive; in fact practically all phases of both offensive and defensive operations including transportation, communications, supplies, etc., are dependent on the weather, and it is known that weather often plays a decisive part in the outcome of the operations, and many an attack, no matter how carefully planned, fails on account of the weather.

IN PEACE

AVIATION: Aviation requirements are practically the same as they are for war, as airline companies cannot take the risks that are inevitable in war; therefore even greater demands are made in time of peace.

AGRICULTURE AND HORTICULTURE: In agriculture there is a very great demand for both long and short period forecasts; the former is a subject of intensive study at the present time, but unfortunately the study has not gone far enough to justify Meteorological Services in issuing forecasts for this purpose. On the other hand, accurate short period forecasts sufficiently long to cover many periods of operation are possible. They are especially required in connection with blizzards, violent storms, severe gales, early frosts, spraying and haying operations; also in fruit growing regions where frost at some critical period may largely destroy the season's crop, timely meteorological warnings can generally help to prevent disaster by modern methods.

FISHING AND SHIPPING: Fishing, and coastal and Great Lakes shipping operations are greatly affected by the weather and it was to assist them that the Meteorological Services were first organized. Accurate forecasts of the weather can effect an immense saving not only in equipment but also in lives, and while forecasts are valuable for ocean-going vessels they are not now the same as when Meteorological Services were first organized.

FOREST FIRE HAZARDS: It is only necessary to point out that forest fire hazards are the direct result of weather conditions, and timely warnings by the Meteorological

Service to the authorities of the approach of hazardous conditions, with their severity and duration, are of great assistance in order that the necessary precautions can be taken.

HIGHWAYS AND RAILWAYS: Accurate forecasts of weather conditions are of very great advantage to the highways departments and the railways in coping with the snow and ice conditions during the winter months, as it enables them to have their equipment ready in advance to meet the situation.

HYDRO-ELECTRIC POWER TRANSMISSION LINES, COMMUNICATIONS, ETC.: These are all affected, at times very severely, by the weather; even the electric load during the daytime depends in many cases on the weather, whether it is bright or dark. The Meteorological Service is being asked by the companies to forecast the intensity of the daylight in order that they may be prepared to meet the expected load on the system. Icing storms can do an immense amount of damage to power and transmission lines and advance information enables the companies to make preparations to meet the situation. Flow of streams depends on precipitation and a knowledge of this is becoming of increasing importance to the hydro-electric and power companies.

INDUSTRY: There are very few great industries that are not affected in one way or another by the weather and their managements are looking to the Meteorological Service for assistance and guidance.

Thus in peace and war the Meteorological Service is an essential function of government.

Meteorological Problems

The secrecy surrounding the Meteorological Services during the war, and the rumours concerning their work, created in the public mind the belief that it would be possible to give almost one hundred percent service, but this is not so. There are still very many factors about the atmosphere that meteorologists do not understand, and it will only be after long and painstaking investigation that they will be slowly unravelled. Unfortunately this side of meteorology is not realized by the general public as the prevalent opinion is that forecasting is about the only function of the Meteorological Service. It is hard to realize that to produce forecasts a great organization is now required to provide instruments and to obtain, collect, and plot on charts observations from many stations; then the forecaster has to analyse these observations from the charts before he is in a position to issue forecasts. Most important of all, investigations have to be carried out at all times to find out the weather processes. This is becoming exceedingly expensive but is one of the most essential functions of the Meteorological Service if progress is to be made and forecasting improved. *Accurate forecasts* cannot be made without *accurate facts* on which to base them.

Thus the first step in any investigation is to find out the facts. In the physical and chemical laboratories, in fact in most scientific laboratories, the first requirements are instruments with which the necessary observations can be made and repeated perhaps by different methods before conclusions are drawn therefrom. These experiments in laboratories are conducted within narrow walls and test tubes, and thus under conditions very different from those in the atmosphere. To a meteorologist his laboratory is the whole world and there are no physical boundaries in the atmosphere, the only boundaries being the earth's surface and differences in the medium itself. Another fact that must be borne in mind is that all the meteorologist can do is to take the observations at the time, but these same conditions will never again be repeated, and hence it is impossible to verify them before drawing conclusions; they have to issue forecasts which are conclusions based on the knowledge they possess of the atmosphere; in fact, the forecaster is not unlike a physician in diagnosing the course of a disease when, with all facilities available to the medical profession, it is at times not possible to diagnose the case properly. This limitation in medicine is understood by the public but the meteorologist is confronted with factors probably more

William Harland

Altocumulus clouds. July 10th, 1948—9 a.m., Toronto, Ontario, looking south.

An exceptionally good photograph of "altocumulus undulatus" clouds. The cloud is formed by ascending air currents which are cooling owing to expansion while in the clear band the air is descending and warming up owing to compression. It might be likened to waves of the sea. It is very remarkable on account of the length and regularity of the bands.

difficult in diagnosing the course of the weather. Just as the medical profession has by long, intensive, and expensive investigation, discovered many causes of human illness, so it will only be by long and intensive investigation of the atmosphere, treating the world as a whole, that meteorologists will be able to constantly increase the accuracy of the forecasts and issue them for longer periods in advance.

Basic Facts on which Weather Depends

It is well at this time to state briefly the principal basic facts on which the atmospheric processes that produce the weather depend, it being understood that there are many factors that have a minor influence on local conditions:

1. The processes occurring in the atmosphere are physical in character and obey the laws of physics.

2. It is the heat from the sun that produces the weather throughout the world. This heat warms the surface of the earth and from it the air; it also evaporates water from all sea and land areas, sets the air in motion and produces ultimately all the varied phenomena known as weather throughout the world. If there were no sun or no comparable source of heat, then there could be no clouds, no rain, no snow, no winds, no climate, no weather, and life as we know it would be impossible on the earth.

3. The rotation of the earth about the sun once a year and the inclination of the axis of the earth to the sun gives us our seasons, the character of which is different in tropical, temperate, and frigid zones.

4. The weather and climate depend on the height of the place above sea-level and

G. M. Dallyn

Fine weather cumulus about 3,000 or 4,000 feet above the surface. During the day the heating of the earth's surface causes fairly strong ascending air currents, the air cooling as it rises until saturation is reached and the moisture appears as clouds. They generally grow until mid-afternoon and when the earth cools, the up-currents cease, and the clouds usually evaporate by evening.

the distance from the oceans, it being markedly different if the place is east or west of the ocean; mountain ranges also have a marked effect on the weather and climate.

5. It is necessary to state very emphatically that it is impossible to determine the weather at a particular point from its geographical position, otherwise it might be possible by mathematical calculation to give the weather for years in advance. The weather at any station or region is the result of physical forces acting on the atmosphere throughout the world, and the weather at a place or region is determined by very many factors which produce the general circulation of the atmosphere and the disturbances set up in this circulation; the general circulation is not stable but ever changing, and

these changes produce disturbances which travel for great distances to give us our varied weather.

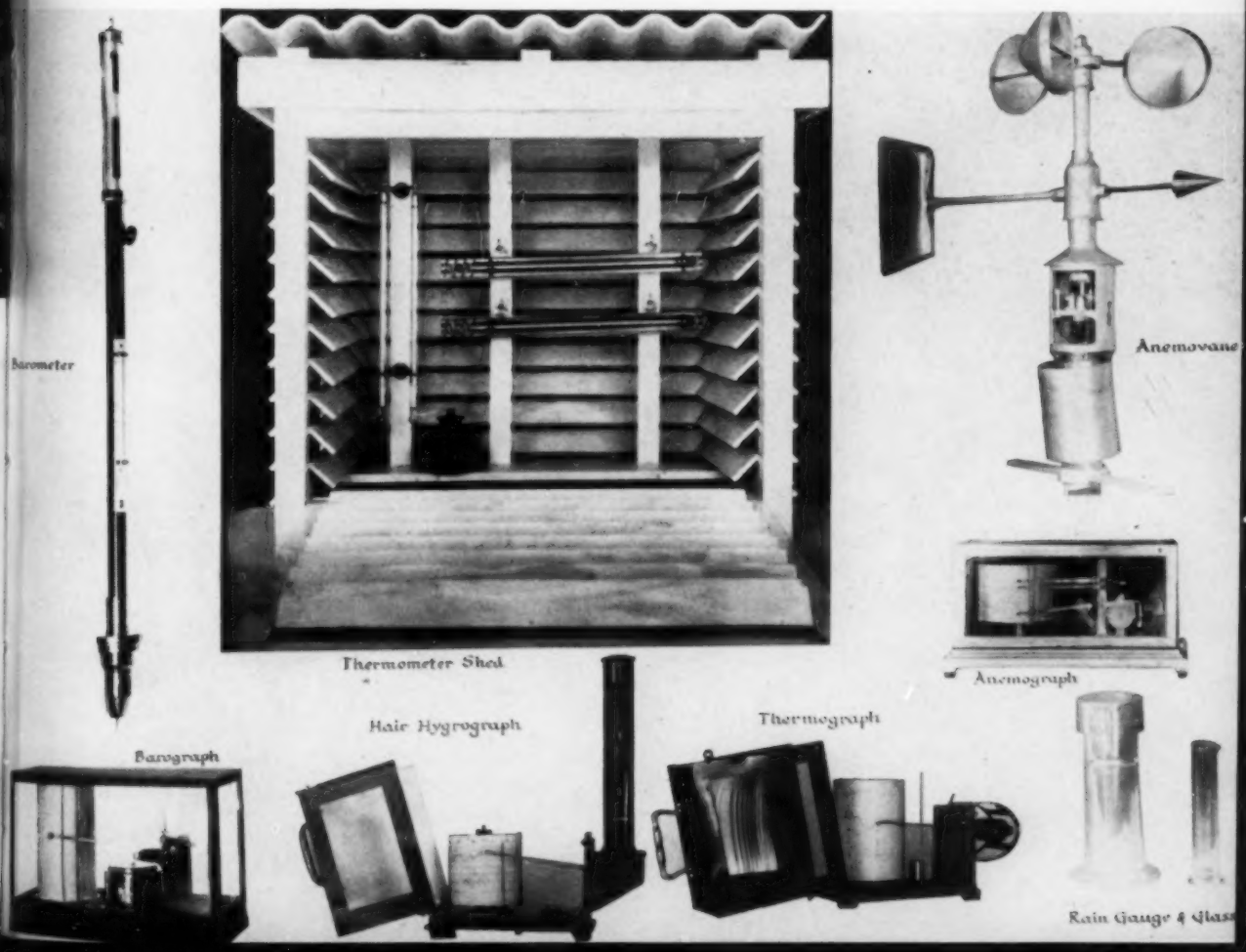
Thus the weather at a place is determined by its latitude, the inclination of the sun to the earth's axis, the altitude above sea-level, distance from the oceans, and the air masses brought to it by the circulation of the atmosphere and the disturbances set up therein.

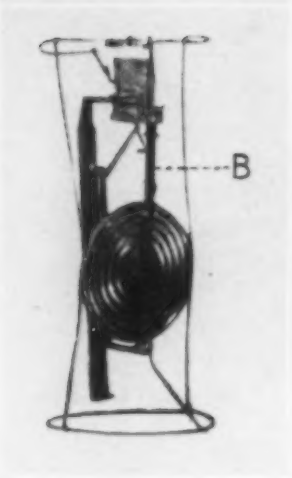
All these facts are related and have to be taken into account in working out the processes that produce the weather. It is a herculean problem that meteorologists are called upon to solve before one hundred percent short and long range forecasts can be made.

Early Developments in Meteorological Science

The science of meteorology began with the invention of the barometer in 1643, and the establishment of observing stations by individuals, then the collection of data at some central station, plotting the data on charts from which emerged the organization by governments of meteorological services, beginning in 1854, then the weather map and forecasts. This also led to the founding in 1878 of the International Meteorological Organization to co-ordinate the work of the different countries so that they could exchange their data and secure uniformity throughout the world. This organization has developed steadily since that time as a voluntary association of meteorologists but it is now to become the World Meteorological Organization as an official body authorized by governments.

The observations at first consisted entirely of surface observations and comprised chiefly pressure, temperature, humidity (amount of moisture in the atmosphere), winds, precipitation, cloud, weather, and later visibility. All these except cloud, weather, and visibility, require instruments for their measurement, and the principal instruments used for this purpose are illustrated in plate 1.





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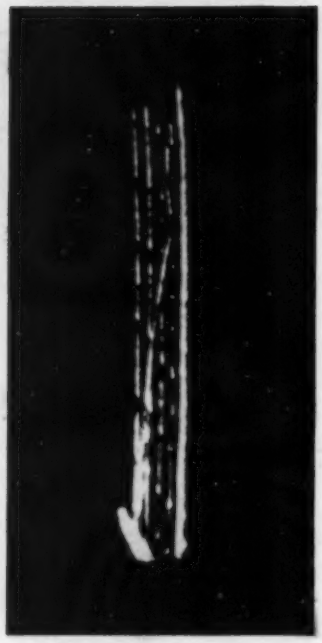

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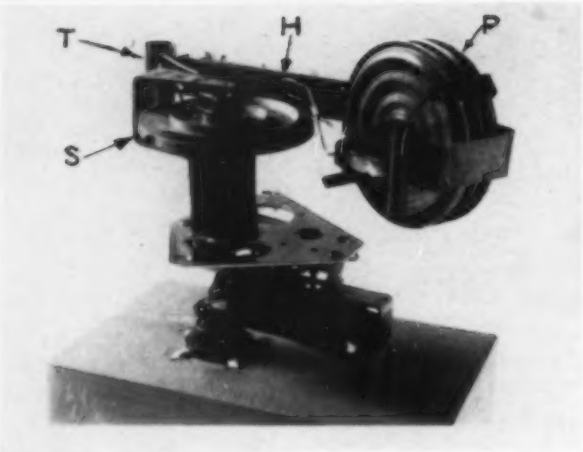

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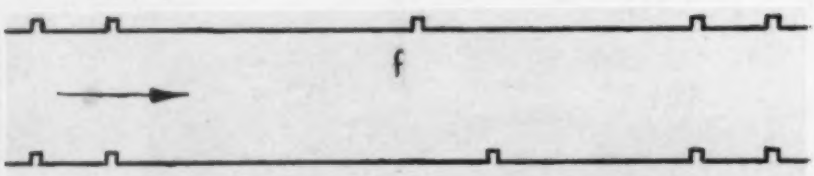

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Upper Air Observations

It was realized from very early times that upper air observations were essential for forecasting purposes or for explaining the physical process in the atmosphere, and in the 17th and 18th centuries some experiments were made by sending up thermometers on kites and by observations from manned balloons. It was not however until 1896 that the International Meteorological Organization began the study of upper air observations throughout the world by a co-ordinated effort, using (1) kites, (2) ballonsondes, (3) pilot balloons, (4) aeroplanes, (5) radiosondes, (6) radar and direction finding, to obtain some or all of the following: pressure, temperature, humidity, wind speed, and wind direction.

1. KITES: As the height to which kites can go is very limited and also the time when they can be flown, they were used only for about fifteen years and then not very widely.

2. BALLONSONDES: The ballonsonde is a self-recording instrument that gives a continuous registration of pressure, temperature, and humidity, sent up on a balloon and with a tag attached asking the finder to return the instrument to the office of origin. One of the very simplest, lightest, and cheapest of these was designed by Dines in England and is shown in plate 2a. This is a most ingenious instrument as it has no clock and the record is obtained on a small silvered plate about the size of a postage stamp. The temperature and humidity elements are carried on the pressure arm and as the temperature and humidity change, the temperature and humidity lines move either nearer or farther away from the pressure line, and by calibrating the instrument before release, the three elements can be worked out. An actual record is shown in plate 2b. The record shows the calibration lines for four different temperatures with the line cutting across them the record of the ascent. The humidity is not recorded. The results are worked out under a low powered microscope. The observations however were of no use for forecasting since the records could not be obtained immediately, as it might be weeks, months, or even years, before the instruments were found; they did however furnish the theoretical meteorologist with valuable data and completely changed the whole idea of the structure of the atmosphere.

3. PILOT BALLOONS: With the development of aviation, pilot balloons were extensively used; they are small balloons which are released and followed through a theodolite (plate 2c); generally the rate of ascent is assumed and then by noting the time, and the azimuth and vertical angles on the theodolite minute by minute, the course of the balloon can be plotted and thus the wind speed and direction obtained at all heights reached; they were available for forecasting but unfortunately they had severe limitations as when cloud was present they were lost as soon as they reached the cloud level.

4. AEROPLANES: The first attempts to get upper air observation in time for forecasting were by means of aeroplanes—a plane going as high as it could and either radioing back the observations or returning in time to make the observations available for the forecaster. This method however was not satisfactory because in very bad weather a plane could not go up at the time observations were most needed; unless special precautions were taken it was difficult to get over 20,000 feet. At the same time there was being developed the radiosonde instrument. The aeroplane however has been used with very great success in reconnaissance flights. On these flights the planes may go from 500 to 1,000 miles out to sea or over sparsely settled regions, taking meteorological observations. The height at which they fly depends on the information that it is desired to obtain, sometimes near the surface, again at high levels. The observations are sent back by radio as soon as they are coded. These flights gave very valuable information on the weather over the Atlantic and the Pacific during the war where observations were exceedingly few and are being continued in the post-war period for the same purpose. One of these flights is from Fairbanks, Alaska, to the north pole and back.

G. M. Dallyn

Cumulus clouds in patches about 3,000 feet above the ground. They are formed in strong, gusty winds which produce ascending and descending air currents, the clouds being in the ascending currents. Very much higher there are a few lens shaped (lenticular) altocumulus clouds.

5. RADIOSONDES: The radiosonde is a meteorograph registering pressure, temperature, and humidity, and geared to a small radio transmitter of short wave length and carried up by a balloon. This transmitter sends out definite signals from which can be worked out the value of the pressure, temperature, and humidity, at all the levels reached by the balloon. It takes about two or three hours from the beginning of the ascent until the observations are received in the forecast office. There are several methods by which the signals can be transmitted to the ground station but one of the best and simplest is based on the Ollan principle and is best illustrated by the radiosonde instrument designed by Mr. R. C. Jacobsen for the Canadian Meteorological Service, illustrated in plate 2d, e, f and g. In this case the spiral S in plate 2d is rotated by clockwork or small direct current motor at constant speed. The penpoints on the pressure P, temperature T, and humidity H elements work at right angles to the spiral. In addition there are two fixed reference points; all of these make contact with the spiral for a brief interval during each revolution of the spiral. As soon as contact is made, a radio signal is emitted and picked up by the receiver which transmits it to the automatic recorder. As the elements change their value the time of contact of each with the spiral will change, and therefore the distance from the fixed reference points at which the elements make contact on the spiral change, as indicated for pressure in plate 2f and g. The two reference points at the beginning and end of the revolution are indicated by two offsets equally spaced and the pressure element by single offset. It will be noticed in g that the pressure element is considerably farther away from the beginning of the revolution than in f. By calibrating the instrument beforehand, it is therefore possible to obtain the value of the pressure

in f and g. In the same way the values are obtained for the two other elements so that pressure, temperature, and humidity at all heights reached by the balloon can be evaluated; the height may be at times up to fifteen to twenty miles.

6. UPPER AIR WINDS ABOVE CLOUD LEVEL: During the war the aviators were exceedingly anxious to obtain the wind speed and direction in the upper air independent of cloud cover, and by the end of the war this information was obtained by three different methods.

(a) *Direction finding from 2 or 3 stations:* A balloon, carrying either a radiosonde or a radio transmitter, which rises at a known rate is released and the angle from the base line between the stations is observed. By triangulation it is then possible to calculate the position of the balloon in space knowing the azimuth of the base lines. By taking observations at minute intervals the wind direction and speed at all heights can be calculated; the height can also be obtained from the radiosonde or the rate of ascent. In the former case all five elements, pressure, temperature, humidity, wind direction, and wind speed, are obtained up to all heights reached by the balloon.

(b) *Radar:* A balloon with a special target and also if desired the radiosonde instrument is released and by means of radar its actual distance away, the angle of the balloon from the north, and the altitude angle are all observed, from which it is simple to calculate the height. By making observations minute by minute the wind direction and speed can be worked out for all heights within the range of the radar set and if the radiosonde instrument is also attached to the balloon, all the five elements are obtained.

(c) *Single station direction finding:* This method was used extensively in the United States whereby a short wave transmitter, generally the transmitter on a radiosonde, is used. The direction from the north and the altitude angle are observed by the direction finder and the height is obtained from the radiosonde, thus again giving all the five elements.

Strategic Meteorologic Stations in the Polar and Sparsely Settled Regions

There has been a great impetus given to establishing stations in the polar regions, sparsely inhabited parts of the world and over the ocean. This has resulted in either Canada singly or in co-operation with the United States establishing new stations at strategic points in the Canadian Arctic, and the maritime countries in the north Atlantic agreeing to provide weather ships to operate 13 stations at strategic points in the north Atlantic, the International Civil Aviation Organization acting as the co-ordinating agency. These ships will be available for rescue work and to give assistance to planes and others requiring assistance. It would not be out of place here to mention that already one of the weather ships operated by the United States Coast Guard rescued all the passengers from a plane that was forced down in the Atlantic and in another case a Canadian weather ship rescued a cargo vessel with a broken propeller caught in the ice.

Meteorological Theory

It is unnecessary here to dwell on the older theory of atmospheric processes by which meteorologists tried to explain the pattern of the weather from laboratory experience. The difficulty with these theories is that the author based his assumptions on laboratory experience, and while he may have produced a brilliant mathematical treatise, since his assumptions were different from those occurring in the atmosphere, the results failed to throw any light on atmospheric processes. It is only necessary to say that the main theory up to recent years was that there are two systems in the atmosphere, one known as "anticyclonic" or high pressure, and the other "cyclonic" or low pressure. The circulation is clockwise in direction in the anticyclonic region and anticlockwise in the cyclonic region. In the high pressure area the cold air is settling down, warming up, and flowing outward in a clockwise direction at the bottom, while in the low pressure area the warm air is flowing inward in an anticlockwise direction,

ascending and cooling, thus becoming saturated and producing cloud and precipitation. These systems move for long distances generally in an easterly direction and produce our varied weather.

One of the first results of the study of upper air observations by means of self-recording instruments was the discovery that temperature does not decrease continuously upward until absolute zero (-459°F.) is reached but at a height of six to twelve miles, where it may vary from -60° to -130°F., it ceases to fall and is either constant or slightly increases with height, while at very high levels it is much warmer. This modified the theories that were in existence but did not appreciably change the prevailing theory until through the investigations of many meteorologists, notably Sir Napier Shaw in *The Life History of Surface Air Currents* and the brilliant mathematical analysis of V. Bjerknes and its practical application by his son J. Bjerknes, it was shown that the circulation which had hitherto been considered continuous from high to low was not so but was discontinuous, and this led to the discovery of the modern theory of atmospheric circulation. MODERN THEORY: The modern theory of atmospheric processes is based on physical laws and these are the same for liquids or gases such as air.

If you have two liquids in a vessel such as oil and water, the water being denser will be at the bottom with a sharp line of separation between the water and the oil above it. This same separation can be obtained if cold water is carefully poured into a vessel of warmer and thus less dense water. Here again the cold water being heavier will sink to the bottom and the warm water lie on top. Also it will take considerable stirring (turbulence we call it) to mix thoroughly the cold and warm water and when they are mixed the temperature and density of both will be the same. It is just the same in the air. If there are two air masses, one of lighter density than the other, the heavier will be at the bottom with the lighter above it. The difference in density is generally caused by temperature differences, the colder being heavier than the warmer so that it is not uncommon to find a very dense cold air mass lying along the surface with much warmer air which is less dense above it.

The Gulf Stream in the Atlantic is well known to almost everyone and to a lesser extent the Japan Current in the Pacific. These two currents are of warm and less dense water, the boundaries of which on the sides and bottom are colder and denser. It is therefore very remarkable and hard to realize that these two currents can exist and maintain their identity, even changing their courses, for such great distances in the ocean, the only boundary being the denser water surrounding them. Numerous experiments have shown that exactly the same condition exists in the air, that there can be two different air currents, one warmer and lighter than the other, flowing side by side and maintaining their identity for great distances before, through turbulence, they finally become thoroughly mixed.

These are the two principal factors on which the modern theory of the structure of the atmosphere is based, and from numerous investigations it is now known that in the temperate and polar regions at least there are two great air masses, one known as the cold or polar air mass and the other the warm or tropical air mass, generally designated "cold" and "warm". The cold air mass as its name implies originates in the polar regions and is cold and dry, while the other, the warm air mass coming from the largely oceanic tropical regions, is warm and generally moist. The boundary between these two air masses is known as a "front", and it is along this front that these two air masses may be said to be at war with one another, retreating or advancing as the case may be, and producing most of the bad weather with which we are familiar.

Based on these factors the old idea of the cyclone and anticyclone has given way to the modern idea and the present conception and development of an ideal cyclone is

pposite page:—Altocumulus clouds 10,000 to 15,000 feet above the valley. In mountainous regions ere are often quite violent ascending and descending air currents, the clouds appearing in the ascending d the clear spaces in the descending currents.

represented in figure 1. In (a) the beginning of the development shows the cold air mass and the warm air mass flowing side by side but in opposite directions, the line of separation or front being indicated by the dotted line. In this particular case, owing to the forces acting on them, the warm air mass makes an indentation in the cold air mass as indicated in (b) and once this development starts it generally goes on to completion. The next diagram (c) shows a fully developed system in which the warm air mass has penetrated far up into the cold air mass with cold air on both sides, and a marked change in wind direction at the boundaries or fronts. The cold air to the east is retreating and the cold air mass to the west is advancing. As the development continues the cold air mass in the rear frequently overtakes the retreating cold air mass and thus forces the warm air above the surface as illustrated in (e). When this happens, it is known as an "occlusion". This cuts off the supply of moisture from the warm air mass and as a result the primary system dies and possibly another may be formed.

What happens in the atmosphere when this action is taking place and what is its purpose in nature's economy? Some think that if the moisture is put into the air by the evaporation from lakes and other bodies of water that it should be a simple matter to distribute it over the land as precipitation, probably near the place from which it is evaporated. This is only true at times, but the big problem is, once the moisture gets into the air, how is it to be taken out? What is nature's process?

The air at a certain temperature can hold a definite amount of moisture and the warmer the air the more it can hold. When air rises, it cools, owing to expansion and consequently there comes a time when it reaches the saturation temperature at which the air can no longer maintain the moisture in the state of invisible vapour and it will appear as cloud. As the ascent goes still higher and with sufficient moisture present it ultimately produces rain, hail, snow, etc., depending on the temperature and other atmospheric conditions.

What is the process to produce this ascending current? A good illustration is that of moist air flowing up against the side of a mountain where the air is forced to rise to get over the mountain and consequently it is cooled as it does so, and if the mountain is high enough the moisture is taken out of the air as cloud and precipitation. Away from the mountains, on the plains and oceans, some other mechanism must take the place of the mountains in order to cause condensation and the process involved is indicated in the vertical section (c), figure 1.

The cold air mass in front of the warm air mass acts as a wedge making a small angle* to the earth's surface and the warm air is forced to flow up this incline. As it rises it produces first cloud, then higher still precipitation, and still higher very high cirrus cloud. The advance of this warm front is generally heralded by high cirrus cloud spreading across the sky from the west as illustrated on page 128 (top). In the meantime the cold air mass to the rear of the warm air is advancing on the warm air mass but instead of coming in like a wedge, sliding in under the warm air, it comes as a great bulkhead which may extend to a height of 1,000 feet or more above the ground, fig. 1c. This huge mass of cold air impinging against the warm air mass forces it up with great velocity and consequently produces violent turbulence, and along this line there is a sudden shift of wind, at times violent gales, heavy thunderstorms, heavy rain, and hail; often cumulonimbus cloud (page 128) announces its approach. It is a narrow band and as the system moves forward the station emerges finally into cold, clear, dry polar air. This advancing cold air mass may overtake the retreating one, fig. 1d, and there either undercuts it or runs up over it as in fig. 1e, depending on temperature differences. In this way the warm moist air is lifted up completely from the surface and again gives continuous, often heavy, rain but the supply of mois-

*In the figure the angle is very greatly exaggerated but actually it is very small only 1 mile in 200 miles which if represented on paper would be only 1/10 inch in 20 inches.

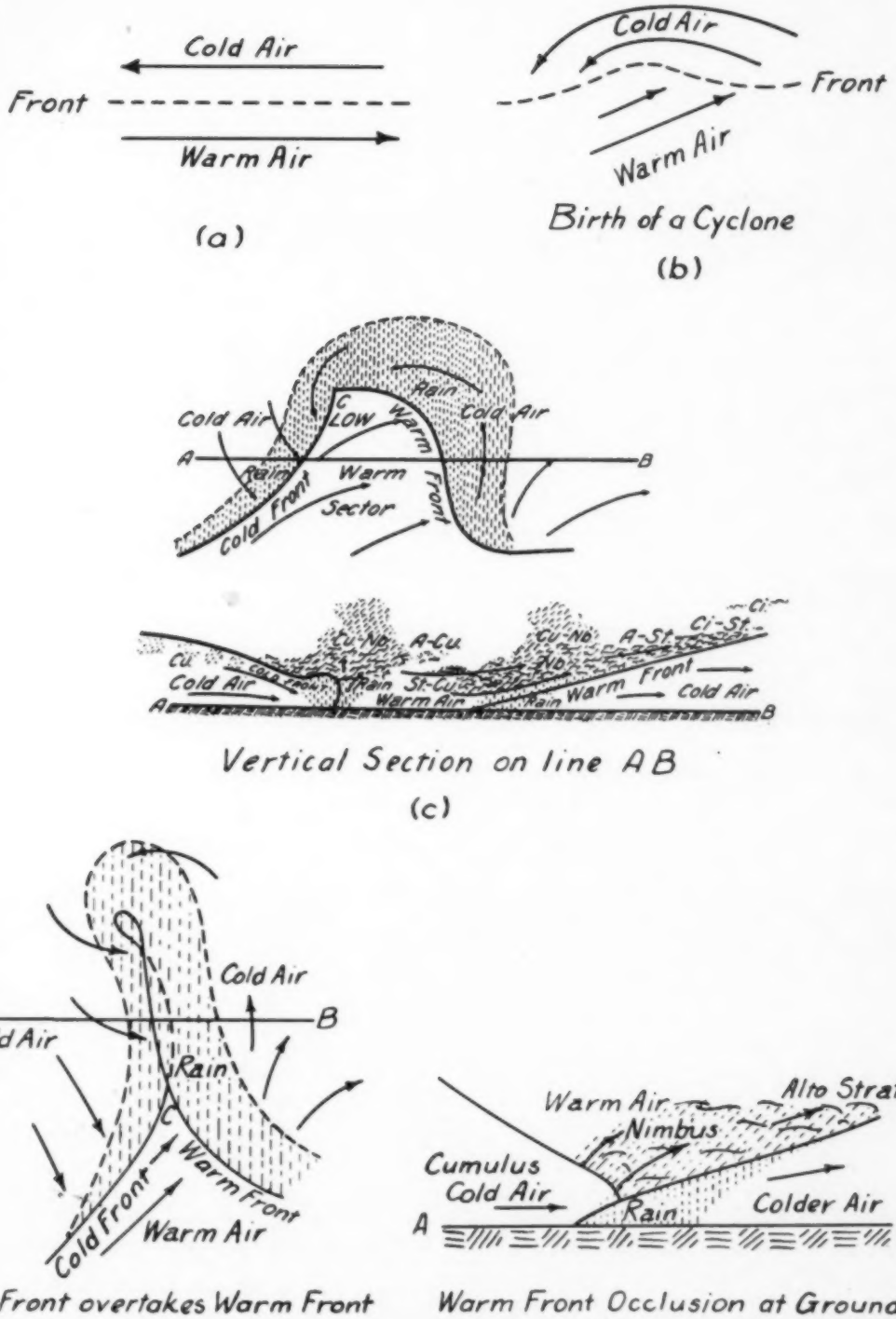
Cold Air
Front
Warm Air
(a)
Cold Air
Front
Warm Air
Birth of a Cyclone
(b)
Cold Air
C
LOW
Rain
Warm
Front
Cold Air
A
B
Rain
Warm
Sector
Cold Front
Cu
Cu-Nb
A-Cu
Cu-Nb
A-St
Ci-St
Ci
Cold Air
Rain
St-Cu
Nb
Warm Front
Cold Air
Warm Air
Rain
Warm
Cold Air
A
B
Vertical Section on line AB
(c)
Cold Air
A
B
Cold Air
Rain
C
Warm Front
Cold Front
Warm Air
Cold Front overtakes Warm Front
(d)
Warm Air
Alto Stratus
Nimbus
Cumulus
Cold Air
Rain
Colder Air
A
B
Warm Front Occlusion at Ground
Vertical Section on line AB
(e)

Figure 1

D. W. Perrie

Cirrus cloud running across the sky from the west heralding approach of a warm front.

Cumulonimbus thunderstorm cloud announcing approach of a cold front.

A. T. McQuarrie

ture is now cut off and the storm ultimately dies.

Such, then, is briefly the mechanism by which the earth is watered to bring forth its increase.

This diagram refers to the ideal well developed case, and as there are all sorts of variations or gradations, the systems can vary from well marked conditions as illustrated above to conditions where it is almost impossible for the forecaster to tell where the boundary is between the warm and cold air masses.

It is this factor and the future behaviour of the system—whether it will develop, disintegrate, slow up, move faster, or change its course—that the forecaster must consider in making out his forecasts, and naturally the longer in advance he tries to make the forecast, the more difficult it becomes.

The process that has just been described of air masses and fronts is in accordance with physical theory, and the photograph below, obtained by a pilot flying at about 20,000 feet approaching the coast of the United Kingdom during the war, shows clearly the cloud produced in the warm air mass which is flowing up over the cold air mass. The boundary between the lower edge of the cloud and the cold air is very sharply defined.

The process illustrates very forcibly how essential it is that the meteorologist should have an understanding of the atmosphere and the processes occurring therein as for instance in (d) and (e), fig. 1, where the warm air is lifted bodily from the earth's surface. There is nothing to indicate on the surface maps that there is a great mass of warm moist air up above which is giving very considerable and, at times, heavy precipitation. A knowledge of the upper air conditions gives this information. Upper air information is now provided by means of radiosonde observations that have become standard routine observations at selected stations as far as possible throughout the world.

Information Obtained from Radiosonde Observations

Radiosonde observations give pressure, temperature, and humidity, for all heights reached by the balloon and from these can be calculated the height of any pressure level and the lapse rate or decrease of temperature with height. Theoretically, dry or unsaturated air decreases at the rate of 5.5°F. per thousand feet of ascent, while if it is saturated with water vapour the decrease is only 3.2° per thousand feet. In the atmosphere it is found that this lapse rate is very variable, often reversed, that is, the air gets warmer instead of colder with increasing height. Again, it may decrease at a greater rate than 5.5°F. per thousand feet. There is also obtained the mixing ratio (the ratio of density of water vapour to the density of dry air) and the

Warm front with the warm moist air shown as cloud flowing up over the cold air wedge underneath.

R.A.F. Transport Command

height of the tropopause (the boundary between the troposphere and stratosphere, which is the surface where temperature ceases to fall and above it the temperature remains constant or slightly increases with height).

There are two fundamental equations for the determination of the properties of the atmosphere. These are (1) the adiabatic equation, which gives the relation between the pressure and temperature in a unit mass of air on the assumption that the unit receives or gives out no heat from or to outside sources during the transition from one position to another, (2) potential temperature, which is the absolute temperature the air would assume if without gain or loss of heat its pressure were altered to normal standard pressure, 1,000 millibars (29.53 inches of mercury). These equations permit the determination of the stability or instability of the atmosphere, the amount of energy in a unit mass and the characteristics of the air mass in the upper atmosphere. It is from these that the boundary between different air masses (fronts) in the upper atmosphere is determined.

The mathematical treatment or a more detailed description of these factors is beyond the scope of this article but anyone interested may find a full treatment of the subject in the standard books on Dynamic Meteorology.

It is only necessary to mention here, however, that all these conditions have their own special effects on the weather; it is impossible to know these from surface observations only, hence the importance of the upper air observations to the forecaster.

Surface and Upper Air Charts

A study of the surface charts on which were plotted the air pressure reduced to mean sea level and other surface observations indicated the possibility of forecasting the weather, and this led to the establishment of Meteorological Services throughout the world. They were the only charts available for forecasting until in the last few years upper air charts were made possible from radiosonde observations. The upper air charts are, however, different from those used at present for the surface. A surface chart gives the pressure at sea level and all the elements that are observed at the surface and from these are drawn the isobars for various difference of pressure, frequently 4 millibars, also the fronts and occlusions. In the upper air however it is found more convenient and lends itself better to research to construct them at constant pressure levels, say 800 mbs., 500, 300, etc. Each pressure level is not at the same height above mean sea level, the level being higher in some places and lower in others. The lines that are drawn give the actual height of the pressure level above mean sea level. These lines roughly correspond to the isobaric lines on the sea level surface map.

The value of upper air maps is well illustrated in the three maps, figures 2, 3 and 4, for November 13, 1946, at 0330Z.

Figure 2 is the surface chart giving the isobars and fronts. In this case the high pressure region 1,032 mbs. is in the Mississippi Valley while the lowest is up over Hudson Strait and the fronts are far to the west and to the north. The fronts to the west are ill defined and practically stationary while a warm front extends along Hudson Bay, with a cold front to the west of the warm front. On the same date the height above sea level of the 500 mb. chart is shown in figure 3, and reveals that the height varied from 19,200 feet above sea level near the Gulf of Mexico to 16,800 feet above sea level over the northern part of Hudson Bay. If the air between sea level and the 500 mb. level should be very cold and thus dense the height would be much less than if the air were comparatively warm and less dense. If only surface observations were available this would indicate that the height of the 500 mb. level would be lower over the high pressure areas which are generally cold at the surface and higher in the lower pressure areas on account of the air being warmer and lighter. The upper air observations however show that it is impossible to determine the temperature from the ground to the 500

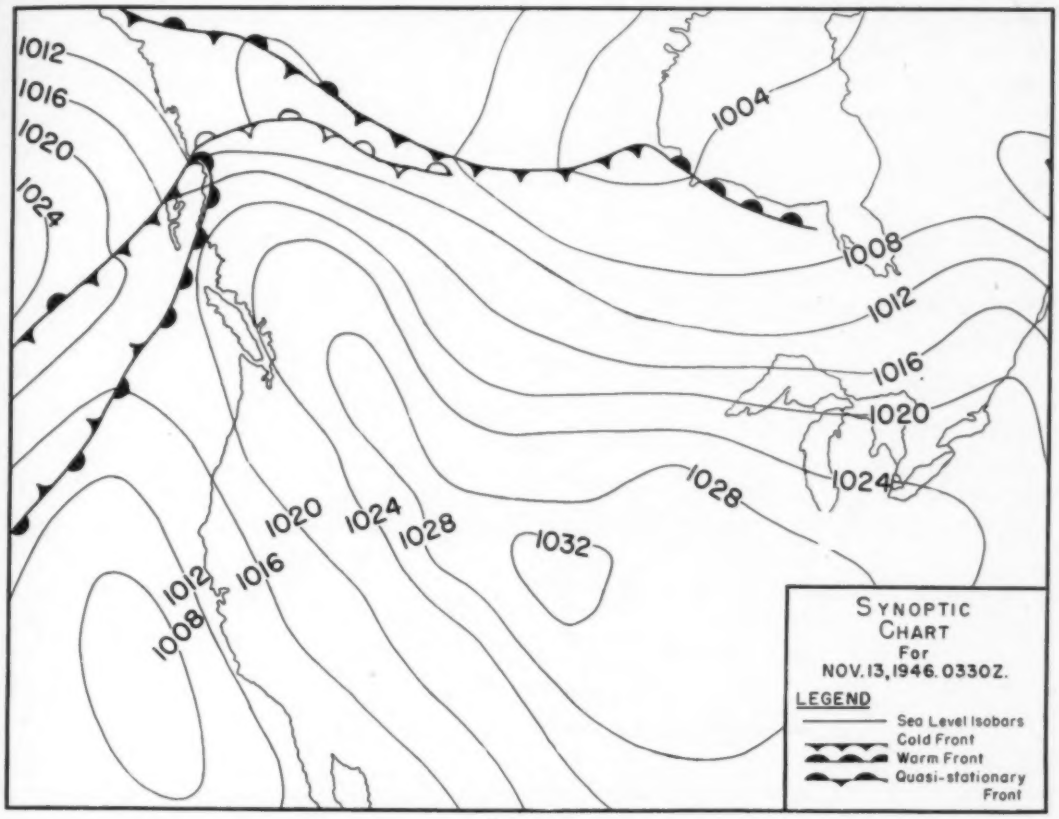

Figure 2

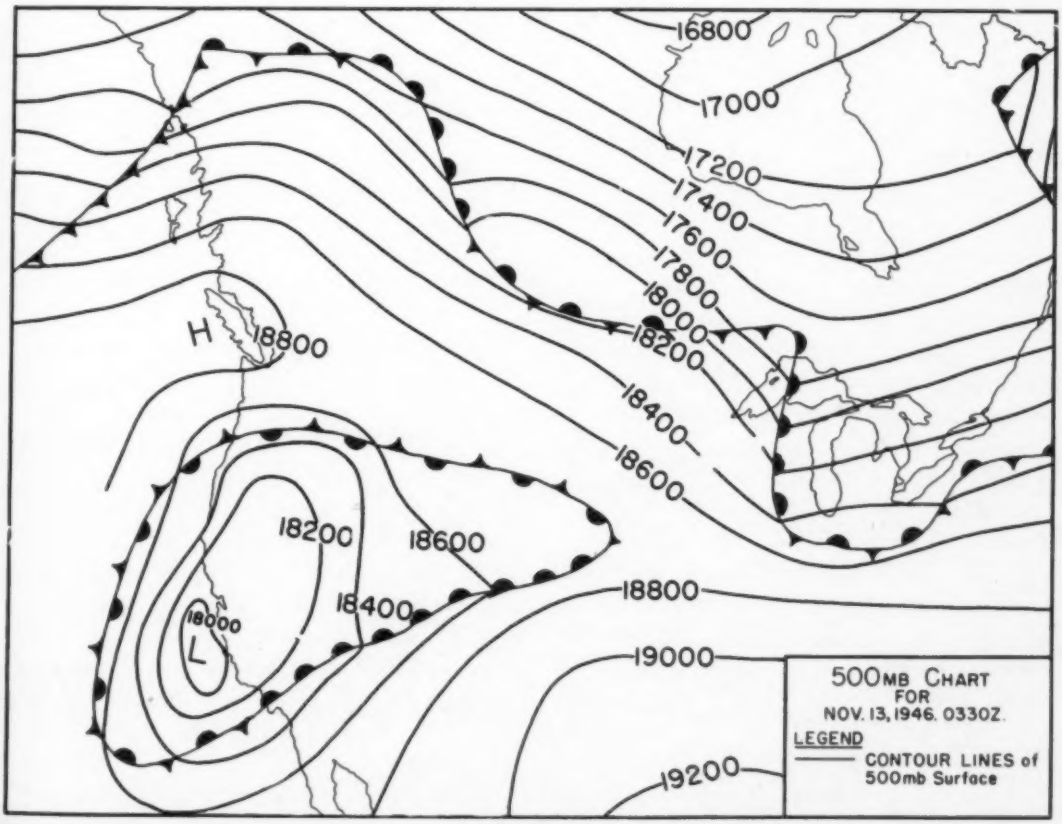

Figure 3

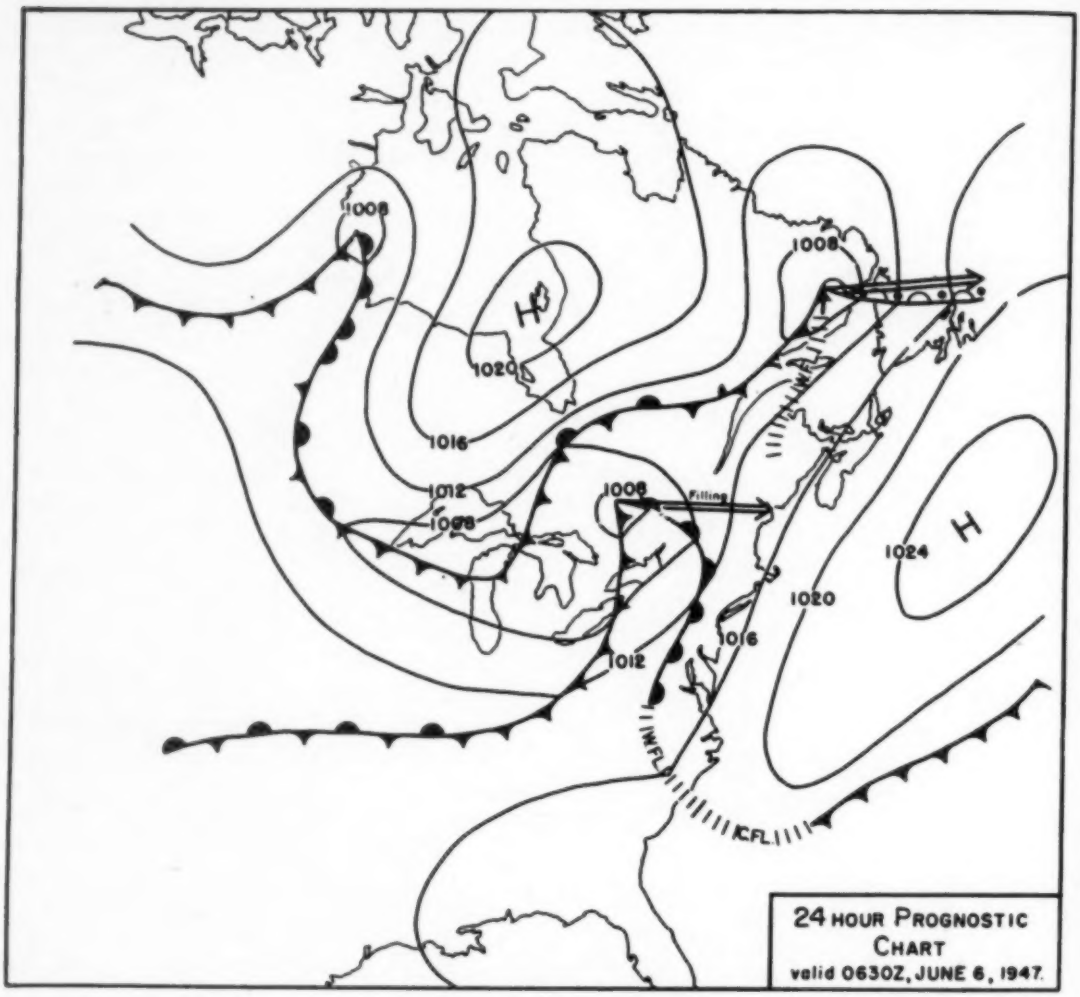

Figure 5

mb. level from surface observations as the temperature decrease with the height is very variable and in many cases it actually remains constant or increases with height between different levels in the atmosphere. In the high pressure areas there is very frequently a decided increase of temperature between some of the lower levels. The actual height of the 500 mb. level, in fact all levels, depends on the thermal conditions in the atmosphere and can only be revealed by upper air observations.

It is interesting to compare the fronts on the surface chart, fig. 2, and on the 500 mb. chart, fig. 3. The front on the 500 mb. level extending right across the north of the continent is displaced very considerably from the one on the surface and there is one extending from the Pacific coast to the Mississippi Valley at the 500 mb. level which has no counterpart on the surface chart.

The third map, fig. 4 (p. 134), is known as a "Frontal Contour Chart". The chart gives the location of the fronts at the millibar levels shown. For instance the 500 mb. fronts are the same as for fig. 3. The fronts for the 400 mb. level follow the same general pattern as for the 500 mb. level. The 400 mb. level front in the Pacific coast region is considerably contracted compared to that for 500 mbs. Again fronts also exist at the 600 and 700 mb. levels in the southern United States with no indication of any

fronts existing at sea level (fig. 2). Sea level isobars approximately correspond to the 1,000 mb. pressure level.

It might just be noted in passing that the isobars are not continuous at the fronts but meet at an angle showing there is a discontinuity. This is due to the fact that the fronts separate two different air masses and this is characteristic of the pressure systems at the fronts on all maps.

It had been the custom for forecasters to make a mental picture of the position of isobars, fronts and pressure systems at the end of the forecast period. Just recently however this practice was changed and the forecaster with all the information available from surface and upper air maps and the use of certain formulae which have been developed draws his conception of the surface map for 12, 24 and 36 hours hence. Examples are given in figures 5 and 6. Figure 5 is a prognostic chart prepared at 0630Z, June 5, 1947, valid for 0630Z, June 6, and figure 6 is the actual surface chart for 0630Z, June 6. An examination of the two charts shows that in general the features of the prognostic chart correspond quite closely with those of the surface chart, but the movement of the fronts, isobars, and high pressure areas were not quite the same as was anticipated; also, there developed a shallow secondary front near the Great Lakes and another front appeared on the western boundary, which were not indicated

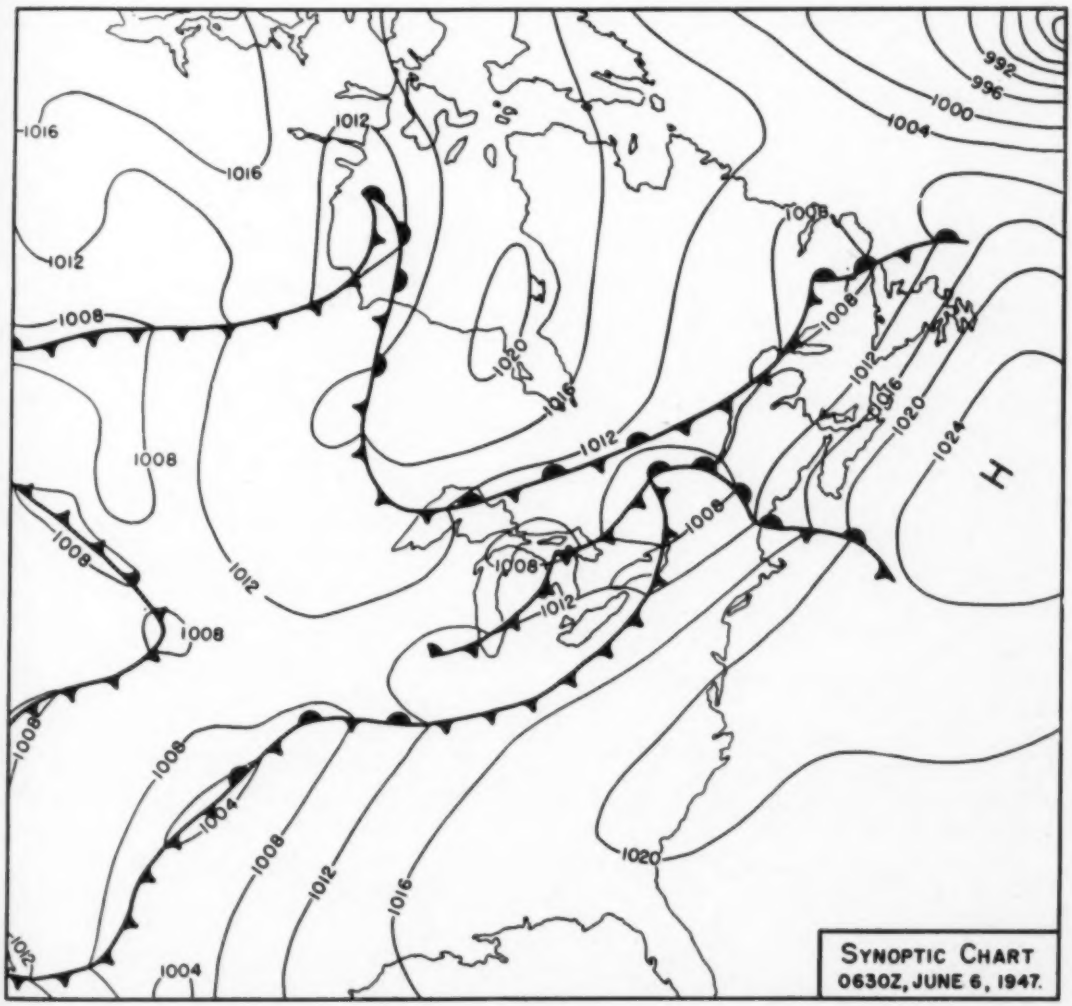

Figure 6

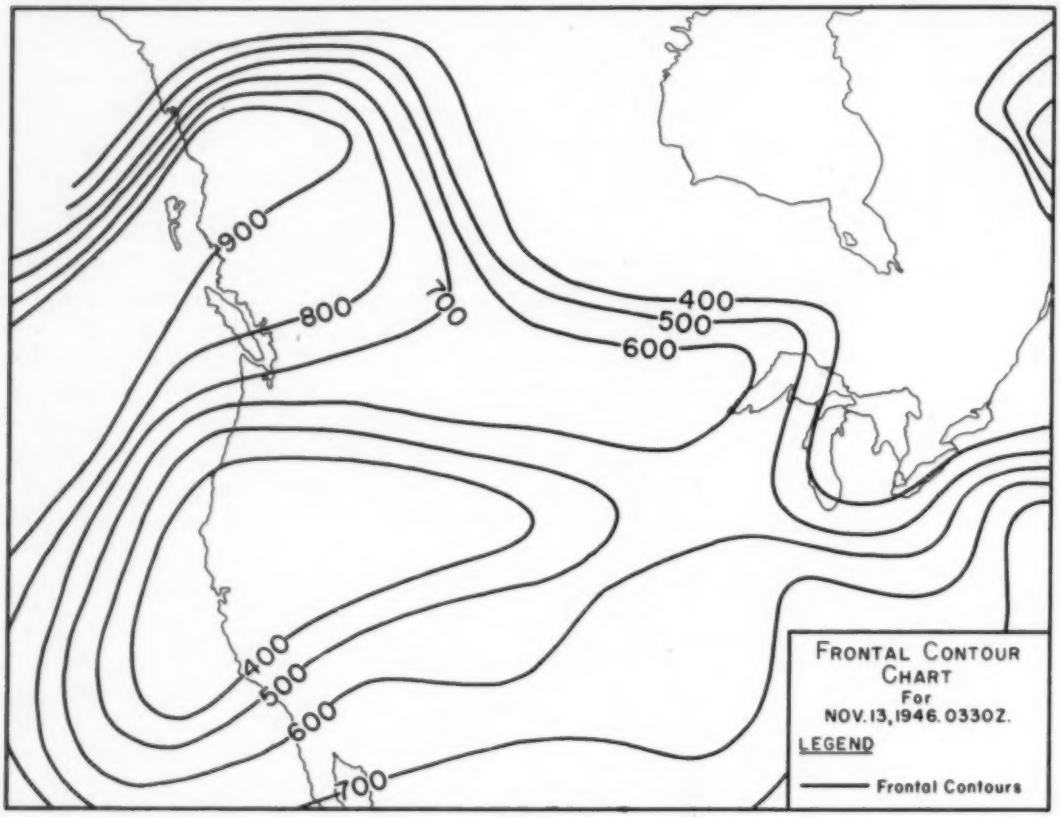

Figure 4

when the prognostic chart was drawn. In other respects the forecaster diagnosed fairly accurately the weather situation at the end of the 24-hour period.

The arrows on the prognostic chart, figure 5, indicate the direction of motion of the system.

The prognostic charts have the great advantage in that the forecaster can see wherein he was in error and thus be able to improve his forecasting, which cannot be done when there is only a mental picture made 24 hours previously.

Radar and Radio-Electric Phenomena as Aids in Forecasting

It has been found that the position of precipitation (rain, snow, etc.) if above a certain minimum intensity can be indicated on the radar screen and not only the position but also the direction and rate of travel can be determined up to a range of about 100 miles from the radar set. Warning is given for a few hours in advance as to whether or not the showers will reach the station and if they do the time they should arrive. The warnings are thus for short periods, of 4 or 5 hours at most, but should be of considerable help to the forecaster at the local station.

Radio-electric phenomena known as "Sferics" is a term applied to the science of location, tracking and determining the characteristics of atmospheric electrical discharges which result from lightning, convection of air masses, discontinuities or fronts, etc. Three or four radio direction finding stations are used to record the azimuth and the accurate time of all atmospheric electricity discharge for a fifteen-minute period during each hour or other suitable period. By laying out on a map the azimuth of each discharge from each station the point of intersection from

Opposite page:—Chinook arch near Calgary, Alberta. Air from the Pacific as it flows inland is to rise as it crosses the mountains causing on the windward side stratocumulus cloud along the top Rocky Mountains; then as the air rushes downward on the eastern slopes it is very dry, with cl skies, replacing the cold air which is draining away to the east, frequently causing a rise of tem of 50°F. or more in a few hours; higher still other currents with more moisture give rise to alto cloud the edge of which is the chinook arch.

all stations gives the position of the electrical discharge.

A special Commission of the International Meteorological Organization was set up in Washington in October 1947 to investigate the problem thoroughly, as results already indicate that the method can locate fronts over the oceans and their rate of movement.

Artificial Production of Rain

Another investigation that is being conducted at present is known as "Seeding the Clouds with Dry Ice" (frozen carbon dioxide, which is about 110°F. below zero). The dry ice in fine grains is scattered on the clouds from an aeroplane. It is supposed to produce a chain reaction which will cause precipitation. It is much too early however to say whether this will be the long sought artificial method of producing rain. It would appear that it could only be successful in special cases for it would be impossible to get precipitation if the moisture were not there.

Necessity of Meteorological Research

From the foregoing it will be seen how upper air observations, especially radiosonde, have increased the meteorologist's knowledge of the atmosphere. They have made available to the forecaster for research an immense number of accurate facts which will mean steadily increasing accuracy in forecasts and their extension for longer periods. The United States Weather Bureau now issues forecasts for five days in advance and is studying the next advance for a longer period. It will be in this way that the period for which forecasts are valid will be lengthened until possibly in time forecasts for months or years will ultimately become possible.

To indicate the tremendous advance from very small beginnings that has taken place in meteorological science since the Meteorological Service was organized in 1872 and the study of forecasting began, it is only necessary to recall that Sir Frederic Stupart and B. C. Webber began this study with observations from only seven stations along the Lower Lakes and the St. Lawrence and fifteen stations in the United States. When one considers the vast number of observations both surface and upper air from the whole continent and the adjacent oceans now available, one cannot help but admire their optimism, self confidence, and abounding enthusiasm when they issued forecasts to a very skeptical public. This they did in face of a ban on the issue of forecasts by the Royal Society of London (which then controlled the Meteorological Office) on the ground that the forecasts were unscientific and that it was contrary to all scientific etiquette to issue conclusions before verification. Time has more than justified the perseverance and optimism that they displayed in the early years.

The meteorologists have thus a great goal set before them in their endeavours to obtain forecasts 100 per cent accurate and for long periods in advance. It can only be achieved by long and painstaking investigations, but so far meteorological research has not attracted heavy endowments from philanthropists. When one considers the immense amounts that are now spent on scientific research in many human activities, the amount spent on meteorological research is insignificantly small. However, medical research has resulted in finding the cause and cure of many diseases with untold benefit to the human race, similarly by encouraging scientific men to undertake the investigation of the atmospheric processes in time victory may be achieved, with resulting benefits to the economic life of the world.

BIRD SERIES — PART IV

Photographs and Notes by W. C. CRICH

CANADA GOOSE *BRANTA CANADENSIS CANADENSIS*

THE common Canada Goose is the best known and the most widely distributed of all our waterfowl. There are in all five subspecies of this bird, but their chief distinction is in size and in the shade of the body colour. Whether on land or on water, the Canada Goose is easily recognized by the long, straight, black neck, the colour of which terminates distinctly, without any blending into the brownish-grey body. This, with the broad, white bib under the chin which extends up onto the cheeks, is the only field mark needed to identify this magnificent bird. Both sexes are marked alike.

The Canada Goose is a large bird, weighing as much as eighteen pounds. Its size, along with its tastiness when served at table, has led to the slaughter of countless thousands. Owing to its wariness and intelligence, however, it has managed to survive the onslaught and even to hold its own.

As a harbinger of spring, it is of secondary importance only to the Robin. As the sun unlocks the ice of our northern lakes, the clear resonant "honks" of these birds may be heard as their calls descend from high up in the still night air. The V formation of a flock of Canada Geese in flight against the moonlit sky is a majestic sight. In late February or early March, as the days lengthen, the geese begin to move northward along the Atlantic coast, and, if the weather continues mild, they move inland and penetrate into the interior. The migration at the start averages only about nine miles a day, but later on in May as they approach their northern breeding grounds, they speed up until they average about thirty miles a day.

The old ganders take their place at the head of the V-shaped formation, and lead the way. Should the flight be a long one, they are replaced by other adults, one at a time, who in turn take over the leadership and guidance of the flock. Flying by day as well as at night, they only stop to rest and to feed. Their breeding-grounds are on both sides of Hudson and James Bays and in the Prairie Provinces southwest to South Dakota. They reach these breeding-grounds early in the season, and their young are hatched and out of the nest before the other fowl arrive.

The young birds mate and breed when three years old, and since the adults mate for life, the birds are for the most part already paired when they reach the breeding-ground. Should either of the pair be killed, it is said that the survivor never mates again.

The Canada Goose generally nests on the ground near water. If, however, the land should be flooded, they will nest in trees, in which case they usually take over and repair the old nests of hawks. The nests are constructed of any nearby material such as sticks and the dried stems of grasses and lined with soft, grey down plucked from the breast of the female. This down insulates the eggs when the goose is feeding; its removal also brings the body temperature of the adult close to the eggs. The eggs vary in number from four to ten and are a dull, creamy white in colour.

Incubation of the eggs lasts for about four weeks. This is done by the female only. The gander stands guard close to the nest and drives away all enemies. He is able to distinguish harmless sounds, such as the splash of a fish, from hostile sounds, such as the splash of a paddle. To the one he pays no attention, while at the other he immediately warns his mate. She stretches her long neck out horizontally to its limit along the ground and then closely resembles a mound of earth or a water-worn boulder. Should an enemy approach the nest, the gander capably takes charge and it would be a brave adversary indeed that could stand up to the terrific bone-breaking assaults from his wings.

It is not only when guarding the home of his future progeny that the gander is solicitous of his family group. When the young goslings appear and move on to their natural element, the gander leads the procession while the goose takes over the rear guard. As the family feeds, never once does the gander lower his long, straight neck, but remains constantly on the alert.

The food of these birds is varied, but the greater part of it is vegetable. In the marshes they feed on the corms and bulbs of water plants, on wild rice, arrow leaf, sedges and other marsh grasses. They eat not only the seeds, but also the roots and leaves. To this vegetable diet are added small clams, snails, and insects. During the fall migration, they like to pick up fallen grain among the stubble of the farmer's field. If early autumn rains have made it impossible for the farmer to harvest his buckwheat, this field is a likely spot in which to find a flock of Canadas. On the coast during the winter they feed on the tender parts of any marine plants that may be available such as algae and the sea lettuce. They are to be found in the winter in southern Nova Scotia, in British Columbia, and along both coasts south of these areas.

AMERICAN WOODCOCK *PHILOHELA MINOR*

THE Woodcock arrives in Ontario shortly after the snow has melted from the alder thickets and the low, damp woodlands which it frequents. The birds appear to have paired before reaching their summer home and immediately on arrival select a nesting site. Their eggs are laid upon the bare ground among the leaves and sticks. The eggs and the adult both closely resemble the colour of dead autumn leaves, and the nest is about the most difficult of all nests to find. The bird, in addition to its protective coloration, is also a close sitter and will often permit itself to be stroked while on the nest. Once when searching for Woodcock nests with a companion he called to me that he had found an egg. I went over to see the egg and beside it, unnoticed by my friend, was a Woodcock. When flushed she was found to have been setting three other eggs. The eye, large and black, was the only clue to give her away and my companion had missed it. Try placing a finger over the eye of the bird in the incubating photograph and see how well she is camouflaged.

The second photograph shows the Woodcock turning an egg over, using her bill as a stop wedge while her toes do the turning. This prevents the young chick inside the shell from sticking to the shell. This photograph was taken not long after a four-inch snowfall. Late falls of snow in the spring often catch the Woodcock with her nest completed and a full set of eggs. Fortunately for her this snow soon melts.

The eggs hatch in about three weeks. The young are quite feeble when first hatched and, if the adult has not been disturbed at the nest, she will brood them there for a day or two. If the adult has been disturbed, the young are carried, one at a time between her legs, to another spot as soon as they are all hatched.

The three young pictured were hatched one evening just at dusk. Early the next morning they were found over one hundred feet away, and still quite helpless. It was impossible for them to have travelled this distance by themselves. The young are also carried from the dry wood in which they are often hatched to the moist feeding ground. The Woodcock is a heavy eater, often consuming its own weight in food in twenty-four hours. Its chief food is earthworms, which it hunts for either at night or in the dusk. The long bill of the Woodcock is specially adapted for probing in the soft, black soil for its food. While doing this the body is raised and lowered in a curious bobbing manner.

H. R. Lillie

The Whaling Industry: Economic Aspects

by W. C. MacKENZIE

THE modern whaling industry began in the 1860's. Its history up to the present falls into two phases: the first dating from the beginning to the end of the first world war, and the second from about 1920 to the end of the second world war.

In the first phase, the industry—like old time whaling—was based on the production of (rather inferior) industrial oils: principally blubber oil (which is a true fat) and also sperm oil (which is a wax).

The blubber oil, used during the first phase of the industry perhaps chiefly as a fuel, was a crude product—dark in colour, evil in smell and taste and high in toxin and fatty-acid content. A process for refining this oil by means of hydrogenation or "hardening" had been devised by French chemists more than fifty years ago, but it was not applied industrially until after 1920—it was not in fact really perfected until 1932. Briefly, the process consists of treating the oil with hydrogen under pressure and at high temperature in the presence of a catalytic agent (usually nickel). The resulting product is a fat well suited for use in the manufacture of soap, and when deodorized, a raw material for food for human consumption, in the form of lard compound or of oleomargarine, that compares favourably with the vegetable oils. A technique had also been developed about this time, in Germany, for converting sperm oil (hitherto used mainly for lubricating purposes) into fatty alcohols and other bases for the chemical industries.

These developments, of course, were part of a general progress in the technology of processing industrial fats. Their effect was to raise whale oil from an insignificant position to a position of the first importance in the economy of fats—and oils—thus inaugurating the second phase of the industry. The market for this product, therefore, expanded to an unprecedented extent and

At top:—A whale-catching vessel approaching anchorage in Penguin Bay, South Georgia, in November.

provided a basis for the expansion in capitalization and scope of operations that took place in the twenty years preceding the second world war.

Since the species of whales available in northern waters had been hunted to the verge of extinction, this expansion had to be directed into new fields. Of the yet relatively unexploited fields, the Antarctic was by far the largest and richest. Whaling, from land stations in South Georgia, had been started there by Norwegian firms in 1904. Since, however, the hunting grounds in the Antarctic are at least thirteen days' sailing distance from the nearest land, expansion through operations from land stations was necessarily limited. The whole operation of handling the whale catch had to be moved to sea and, since outboard flensing is impossible in the rough Antarctic waters, self-contained floating factories were required provided with slipways to bring the whale carcasses aboard for processing.

The first modern pelagic whaling expedition was sent to the Antarctic by a Norwegian firm in 1925, soon followed by other countries. Between then and 1939 the output of whale oil increased nearly tenfold. From about 1930 forward ninety per cent of the world's supply was provided by the industry in the Antarctic. The average annual prewar production was approximately 500,000 long tons. Almost all of this was consumed in the countries of north-western Europe:

Germany	180,000
United Kingdom	120,000
Holland	80,000
Norway	55,000
Denmark	35,000
All Others	30,000

At this time, whale oil constituted almost 10 per cent of the total supply of fats on the world market, estimated at somewhat less than 6,000,000 tons. More significantly, it constituted about 20 per cent of the supply of industrial and edible oils—the principal competing substances being palm, soybean and cottonseed oils. Before the war, whale oil sold on the London market at lower prices generally than these competing oils, and the United Kingdom utilized it as the raw material for 40 per cent of its margarine, 30 per cent of its lard-compound and 15 per cent of its soap production.

Toward the end of the period, the market for fats and oils became glutted, and whale oil prices declined from an average of about £30 per ton to a point between £12 and £15 per ton. This situation changed rapidly with the approach of war and there developed a general scramble to secure supplies of the material for stockpiling for whale oil stores well (up to five years) under proper conditions. In this, the United Kingdom was most successful and in the last year or two before the war acquired about half of the total world production. Under the control of the Food Ministry, stocks slightly augmented from wartime production were (barely) sufficient to meet requirements to the end of the war. At the same time, the controlled price gradually rose from £30 to over £50 per ton

During the war, whaling, excepting at a few isolated land stations, practically ceased. The whaling fleets of the belligerents were requisitioned for war service and, when the war ended, all the factory ships of the United Kingdom, Germany and Japan, and all but three of the Norwegian ships, had been lost. A large number of the catcher or killer vessels were also destroyed and some of the land stations (including those on the Canadian Pacific Coast) were closed down.

Following the war, two factors produced a strong incentive toward the rapid rehabilitation of the whaling industry. The first of these was the desperate shortage of fats resulting from the war-time devastation of large tracts of the vegetable-oil producing territories in the East Indies, Manchuria and elsewhere. It has been estimated that the available supply was probably not more than half of what could have been absorbed. The other factor was the need on the part of countries like the United Kingdom and Norway to augment their resources in foreign exchange or, alternatively, to increase their self-sufficiency in the supply of essential fats.

Accordingly, in 1946, the British government raised the price of whale oil to £75 per

ton in June—the time at which the new Antarctic "crop" appears on the market. Plans were already under way to rebuild the fleet. Such good progress was made in this direction that in the 1947-48 season seventeen expeditions participated in the Antarctic pelagic operations, distributed nationally like this:

Norway	9
United Kingdom[1]	4
Netherlands	1
U.S.S.R.	1
Japan	2

More than 200 catcher vessels and nearly 7,000 men were employed with this fleet. Of the factory ships, seven (four Norwegian and three British) are newly constructed—the others pre-war survivals and newly converted tankers. The larger proportion of the catcher fleet also consists of new vessels. One or two additional factory ships and a number of new catchers have been launched since last season. It appears, therefore (unless international co-operation in this field should break down), that the Antarctic fleet may finally consist of about twenty units. There are floating factories operating in other areas (two in 1947-48) and over thirty land stations, but the output of all these combined is relatively insignificant.

The new floating factories and whale catchers embody all the results of recent technological progress in ship construction and in the design and equipment of food processing plants. In size, the mother ships are all close to the 20,000 to 25,000 d.w. tonnage (up to 20,000 tons gross) which has been found most satisfactory for operations in Antarctic waters. The size and power of the catcher vessels have been increased and now average over 300 tons gross and over 1,200 h.p. respectively. The number of catchers serving each factory ship has also been increased, being now twelve or more in some instances. This last development is probably the result of the greater operating efficiency of the factory ships. It may, however, be related to the decline in the yield per "catcher's day's work" in recent seasons in the Antarctic, necessitating a larger number of catchers to maintain factory operation at full capacity.

The reconstruction of the whaling fleet has been accomplished under highly inflated cost conditions. A modern floating factory costs about $6,000,000 to build and equip, it is reported, and a catcher vessel $500,000—costs that are five times those of 1939. Allowing for the consequently heavy depreciation charges, and including insurance, wages and other operating and maintenance costs, the annual expenses of an expedition to the Antarctic must be close to $2,000,000 at the present time. Assuming a production of 20,000 tons of whale oil for the season which is somewhat less than the maximum capacity of the newer factory ships, but considerably more than a one-twentieth share in a total production of, say, 300,000 tons (the yield to be expected from the international quota of 16,000 "blue whale units"), this works out at a production cost per ton of about $100.

At the prices obtained for whale oil since the war, high net profits have been realized even at this cost level. In the spring of 1947, the price reached an all-time high of over $400 (£100) per ton, but it has been receding since that date. With unsettled conditions in several of the areas producing vegetable oils, a deficit in the fats supply is likely to continue for some time. This deficit gradually will be overcome, no doubt, and prices will be reduced to a "normal" level. A normal level for whale oil has been estimated at $140 (£35) per ton. Considering the complex relationship among this product and the various competing products, one hesitates to accept any such estimate. This much may be said, however: because of the comparative inflexibility of its supply (assuming that international control continues), whale oil enjoys an exceptional advantage in periods of scarcity in the fats market—and probably suffers from a like disadvantage in periods of glut.

Whether the inflated capital investment can be written off to a more manageable level before the return of intense competition in the fats market depends largely on how

[1] The British expeditions included one ship of South African registry.

long the present period of scarcity and high prices lasts. The price of whale oil may be supported by extending the range of its utilization. Potentially, the crude oil is reducible to a wide variety of commodities, including hydrocarbon products (acids, esters and ketones—besides the edible and other oils) and oxygenated compounds (alcohols, aldehydes and ethers). On the other hand, costs (per unit of output) may be reduced—in individual cases—by production in excess of the average quantity assumed above, and by employing the factory ship as a tanker during off-seasons.

The fact, however, that the total catching and processing capacity of the whaling fleet now far exceeds the limit set by international agreement (and it is unlikely that the limit will be raised) suggests that, in order to increase the net return to the whaling enterprise in general, a more complete utilization of the whale carcasses is necessary. Among the possible derivatives, now largely or altogether wasted, are vitamins from the liver, insulin from the pancreas and hormones from other organs of the whale. But undoubtedly the most important item awaiting further recovery is meat for human consumption.

It is reported that on the average a whale carcass in good condition yields 10 tons of meat (more or less, depending on the species). About 30 per cent of this is steak meat (from the back and under fillets), 20 per cent is sausage meat and the remainder animal food—the proportions vary with the age of the whale. Some 400,000 tons of meat, therefore, could be provided by the world's whaling industry each year—300,000 tons by the industry in the Antarctic alone—and half of this quantity could be used for human consumption.

Although certain quantities of whale meat have been recovered regularly by the Japanese and recently also by the Norwegians (at their land stations) and the British (in their Antarctic operations), a number of obstacles must be overcome before anything like the potential supply is obtained. In order to ensure the maximum recovery of meat in fresh condition, three things are required: (a) an effective method must be devised to kill whales quickly, (b) the carcasses must be bled and cooled at once, (c) they must be processed with the minimum of delay and the meat "deep" frozen—since processing must take place at great distances from the market in nearly all cases.

The first of these requirements appears to be met by the use of electrocution (cf. Dr. Lillie's article). The second has been met, on an experimental basis at least, by removing a section of blubber from the belly of the whale immediately after killing and admitting the cold sea water. Speeding up the rate at which whale carcasses are processed on board the factory ships or at the shore stations, and installing the necessary freezing and storing equipment, are minor engineering problems.

Yet, there is no doubt that these developments would involve a fundamental change in whaling operations. Although (since the oil content of whale meat averages under 10 per cent) the recovery of all edible meat would reduce oil production by less than 40,000 tons, the meat crop potentially exceeds the oil crop in value.

It is not impossible, therefore, that the floating factories and shore stations will become perhaps essentially meat processing and storage plants, with oil in the nature of a by-product.* This would be in line with the general trend toward the maximum utilization of agricultural and fisheries resources to feed the world. In any event, we may conclude that the whaling industry has entered a new, a third, phase of its history.

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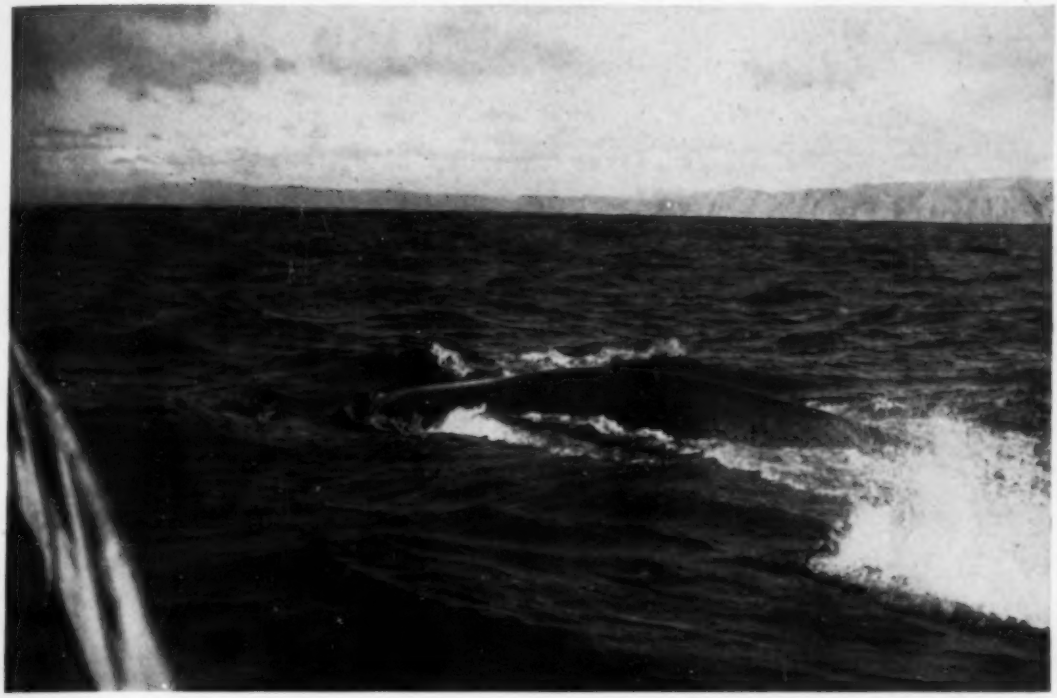
*Since this was written information has been received that the new whaling station in Iceland will concentrate on meat production.

Farmer Whalers

New Zealand Government photographs

SOME of the world's most unusual whalers are the New Zealand sheep farmers who live along Cook Strait. Between June and August these men go out in small boats to hunt the humpback whales that pass through the Strait.

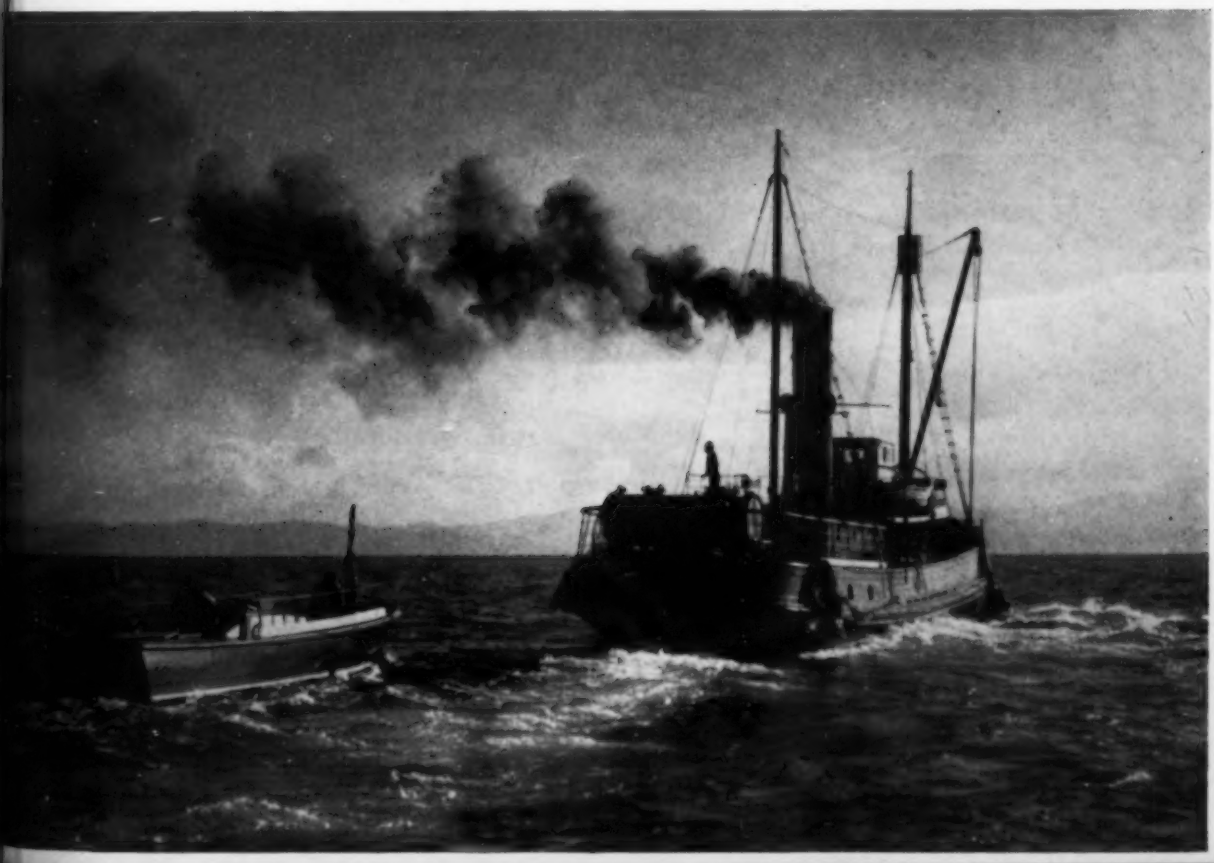
The whaler-farmers watch from a high headland for signs of a whale. Each notch on the lookout chair pictured represents a whale which has been first sighted from it. With their powerful glasses, experienced watchers can pick up the "blow" of a whale twenty miles away. As soon as the signal has been given, all hands rush to the dinghy and row with all speed to the chaser anchored off-shore. The harpoon gun is made ready and loaded and the gunner stands by as the chaser approaches the mother ship, in this case the tug *Tuatea*.



Directions as to the position of the whale are given by radio from the watcher on the lookout. When the whale surfaces the chaser dashes in at any speed up to forty knots. Gunner and pilot work as a perfect team and the harpoon is fired at a range of from fifteen to twenty yards. On being hit the whale sounds and the pilot must manoeuvre the chaser so that it is not smashed by the powerful tail flukes of the whale.

The whale may be killed after the first strike by a lance-bomb fired electrically from the chaser or by running up on the whale and throwing a hand-bomb, or it may drag the chaser for some time. As soon as the whale is dead a long tube is inserted into the carcass through which air is pumped in order to keep the whale afloat. It is then towed alongside the mother ship and hitches put round its barnacled tail.

With the whale made fast to the tug by heavy cables around the flukes, the *Tuatea* heads for home with the chasers following in her wake. In the factory on the shore the oil will be recovered from the blubber, some meat canned for human consumption, the residue converted to fertilizer. Then the whalers will return to their farming.



EDITOR'S NOTE-BOOK

William Sherwood Fox, Ph.D., LL.D., F.R.S.C., has the distinction of being a Canadian of the ninth generation on the paternal side. Receiving his early education in Toronto, he pursued his studies at the Universities of McMaster, Toronto; Geneva, Switzerland; and Johns Hopkins, Baltimore where in 1911 he was the first to receive a Ph.D. in Classical Archaeology. Dr. Fox's academical career took him to Brandon College, Manitoba as Professor of Classics; Johns Hopkins University as Fellow in Classical Archaeology; and Princeton University as Assistant Professor of Classics. In 1917 he went to the University of Western Ontario as Professor of Classics, later to become Dean of Arts and finally, for twenty years, President and Vice-Chancellor, retiring in 1947. Dr. Fox is the author of several books and numerous articles on, among other subjects, education, archaeology, the early history of Ontario, and the natural history of southwestern Ontario. For more than fifty years he has been interested in the story of Huronia and in the search for the scene of the martyrdom of Brébeuf and Lalemant. He has now written a book on the discovery and excavations of St. Ignace, *St. Ignace, Canadian Altar of Martyrdom*, which is shortly to be published by McClelland and Stewart of Toronto.

* * *

Harry R. Lillie, M.B., Ch.B., B.Sc., A.M.I.C.E., comes from Dundee, Scotland. For some years Dr. Lillie was a practising civil engineer before he decided to return to university to qualify as a surgeon. During the war he served with the navy in combined operations in the Atlantic, Pacific and Mediterranean. In 1946-47 Dr. Lillie was in the Antarctic as surgeon to one of the Scottish whaling fleets. During the past year Dr. Lillie has been travelling, lecturing, writing and carrying on research work in Canada, United States and Newfoundland.

* * *

John Patterson, O.B.E., M.A., LL.D., F.R.S.C., was born in Oxford County, Ontario, and graduated from the School of Practical Science at the University of Toronto, being awarded the gold medal in physics and the 1851 Exhibition science research scholarship. He spent two years in post-graduate work at the Cavendish Laboratory and received his B.A. and M.A. from Cambridge University. After two years as Professor of Physics at the University of Allahabad, Dr. Patterson was appointed Imperial Meteorologist to the Government of India, which post he held for five years. He then returned to Canada as physicist in the Meteorological Service, becoming Director (later Controller) in 1929 and retiring in 1946. Requirements of the air forces during World War II necessitated great expansion of the Meteorological Service headed by Dr. Patterson and extension of observations into the arctic regions; Dr. Patterson designed a three-cup anemometer and made important improvements in many of the meteorological instruments. Dr. Patterson is the author of numerous articles on meteorological subjects.

* * *

W. C. MacKenzie is a native of Cape Breton Island. While his name gives clear evidence of his Scottish descent, it is even more impressive in the form which he claims would identify him among the Gaels of the Island—mac Néill Mhurchaidh Aonghais Néill. Mr. MacKenzie (as we continue to call him) studied at Dalhousie University and later joined the staff of the Dominion Department of Fisheries. During the war his work was chiefly connected with the planning and administration of the international allocation program for fish products. He is now in the Economics Branch of the department, directing research in production and related problems.

* * *

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LECTURE

EAST GREENLAND—PAST AND PRESENT

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AMONGST THE NEW BOOKS

The Rise of Toronto, 1850-1890

by D. C. Masters

(The University of Toronto Press, $3.75)

In recent years so much has been written about Toronto either by people who regarded her with a bitter, and somewhat jealous hatred, or by those who felt called upon to justify her peculiarities, that it is refreshing to come upon this study of the city's growth. Here we have an account written by a person of discernment and with an air of scientific detachment. Moreover, Professor Masters cannot be accused of provincialism since he has brought to his research a broad background of experience in other parts of Canada and in the United States.

Evidently the germ of the idea for this study infected Professor Masters, who is a graduate of the University of Toronto, while he was working as research assistant for Dr. Cyril James in Chicago. Applying the information gathered for *The Growth of the Chicago Banks* he began to wonder whether it might not be possible to trace a similar growth within the Canadian scene. Further impetus was given to this idea by the account of metropolitan development given by N. S. B. Gras in his *Introduction to Economic History*. According to his analysis the growth of a metropolitan centre could be traced through four clearly defined stages; that of establishing a well organized marketing system for the area in which it was situated, that of increasing the development of manufacturing in the metropolis or in its hinterland, that of implementing a program of transportation expansion, and that of constructing a mature financial system.

Because of his own interest in the Ontario scene, Professor Masters decided to apply the criterions worked out in American studies to the growth of Toronto into metropolitan stature. He chose for a starting point the year 1850 when Toronto was not a great deal larger and more important than other centres in Canada West such as Kingston, and he carried the study through to 1890. In a subsequent volume he plans to continue into the twentieth century.

This first volume begins with an introductory chapter to set the stage for the future growth. Briefly he traces the development of Toronto through the stages of French trading post, frontier town, government centre, and rebellion headquarters to its position in 1850. By that time it had become the largest city in the province with a population of 30,775. It was now the principal marketing centre for a settled area which extended to the American border on the west and to the Muskoka district on the north. Already the pattern for future economic development had been laid.

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But the book deals with many other aspects of metropolitan life besides the economic. Each chapter covers one stage within the forty-year span and besides the economic, we find traced the social, political, religious and cultural trends which have combined to force Toronto into a position of pre-eminence over its earlier rivals.

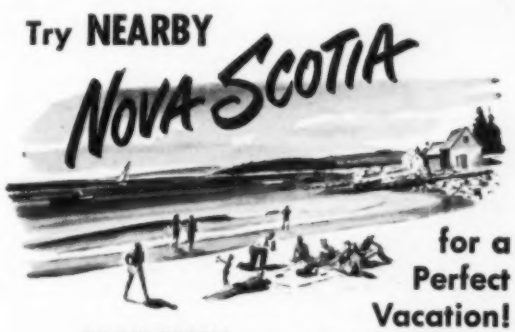
In many ways the ordinary reader will be most attracted to the book through these glimpses of the social life of the growing city. Here Professor Masters has drawn on a great wealth of material available in contemporary biography, sketches and newspapers. Church records, too, give a vivid picture of the way the city gradually extended into the suburban areas. All sorts of odd bits of information about the beginnings of Toronto institutions such as the school system, the public libraries, the Canadian National Exhibition, the T. Eaton Company, and the various newspapers, are combined to give a picture of the many-sided life of the expanding metropolis.

A good deal of thought has been given to accusations that the city is "Tory", "Orange" and "anti-French". Professor Masters has also traced the reasons for its rivalry with Montreal, already established as a banking and marketing centre long before Toronto could make any such claims. The city's close ties with the commercial developments in the United States and with the city of New York are also accounted for, as well as its continued and influential interest in the Canadian Northwest. Enough light has been shed within the compass of this volume to permit the reader to see the general trends and the reasons for them.

If there is any criticism of the book it might possibly lie in the omission of many anecdotes about Toronto personages that could have been included had the book been less compact. The account of the clash between Professor Goldwin Smith and Colonel George Denison at a dinner at the National Club in 1885 is so revealing of different points of view within the Toronto framework that one cannot help wishing for a large number of similar illustrations. On this occasion the radical exponent of a closer tie between Canada and the United States had proposed as the topic for after-dinner discussion, "Annexation or Independence would be best for the future of Canada". Each person present was called upon to give his point of view on the question. Finally Colonel Denison rose to his feet. "I could not argue in favour of either Independence or Annexation," he exclaimed. "If ever the time came that either had to be seriously discussed I would argue it only in one way, and that would be on horseback with my sword."

Professor Masters' book is certainly a valuable addition to a growing body of literature which is dealing with social, economic and historical development of various parts of Canada from a critical and analytical point of view. This importance must have been realized by the Canadian Social Science Research Council which made a grant to facilitate the publication of the study. Serious students and laymen alike will look forward to the continuation of the picture in the subsequent volume.

AUDREY SAUNDERS MILLER.



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